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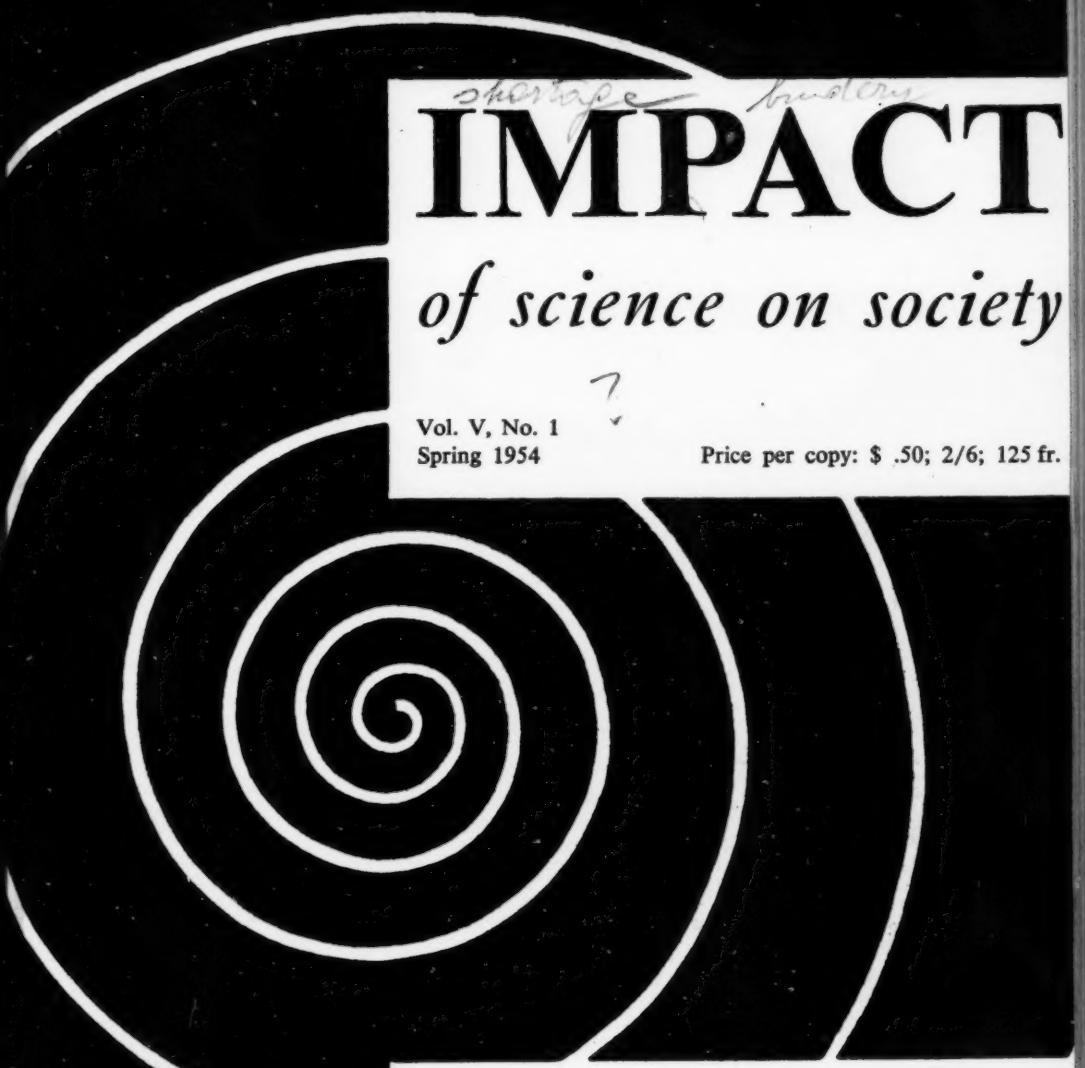

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SCIENCE AND THE PREVENTION OF CRIME

by

OLOF KINBERG

Professor Kinberg is a distinguished Swedish criminologist who for over forty years has been carrying out research on criminal psychiatry and the biological causes of criminality. He is author of nearly three hundred papers and several books, including Basic Problems of Criminology, *London, 1935, and is Director of the Institute of Criminology of Stockholm University, which he himself founded in 1946.*

For centuries crime was regarded as a sin. The perpetrator of a criminal act distrubed the balance of a universally accepted system of absolute moral values. That balance could only be restored by inflicting suffering on the sinner; and retributive justice (as it was called) demanded that 'the punishment fit the crime'.

This approach to the problem of crime was based on metaphysical and theological concepts. The predominant factor was the criminal act itself, the individual who had committed it being considered of secondary importance. He was of interest to society only as a moral debtor, liable to punishment corresponding to his debt; he was thus like the scapegoat of antiquity. Nobody was interested in a delinquent's social destiny, in his chances of being able to redeem himself socially and resume his place among his fellow-citizens. The only human concern shown for him was of a religious kind—concern that he should try to redeem his soul by contrition and repentance. Otherwise, he aroused neither interest nor compassion. This explains the curious fact that, even nowadays, professors of penal law can spend their whole lives teaching, without ever having set foot in a penitentiary. It also explains why, for centuries, convicts have been treated with disgraceful negligence and revolting heartlessness. Seneca's dictum *Nemo prudens punit quia peccatum, sed ne peccetur*[1] was, in the metaphysical and theological philosophy of criminal law, either ignored or forgotten for hundreds of years. It has now become the guiding principle of modern criminology.

THE PERSONALITY OF THE CRIMINAL

The evolution of psychiatry during the nineteenth century, the increasing attention which psychiatrists have devoted to crime, and the theories of

1. A wise man does not punish for the commission of an offence, but in order that offences shall not be committed.

Lombroso and his followers concerning the genesis of crime have led to a radical change in the approach to this problem. As a doctor, Lombroso was convinced that the causes of criminality should be sought in the criminal's bio-psychological characteristics, and that the knowledge thus obtained should be used in the struggle against crime. Thus the personality of the criminal, which had long been shrouded in metaphysical and theological obscurity, was at last exposed to view by the medical and biological sciences. After the publication of Enrico Ferri's *Theory of Imputability and Negation of Free Will* in 1878, people began to realize that this metaphysical problem was not subject to the test of experimental research on the causes and treatment of crime and that it should not, therefore, be taken into consideration in the eminently practical and empirical application of criminal policy. Some thirty years later, in a book published in 1913, O. Kinberg showed that 'imputability', or moral responsibility, was not an actual psychological state whose existence could be proved objectively. If it were assumed that such a state existed, a distinction would have to be drawn, among mentally diseased persons, between those who were morally responsible and those who were not—a task which is obviously unreal.

If, however, the criminal is regarded as the protagonist in the drama centring around the crime, then knowledge of the causes underlying his criminal action, i.e. the aetiology of crime, becomes the prime problem; it becomes, indeed, the central question in criminology, for without a knowledge of the factors generative of crime it is difficult to find ways of preventing or restraining criminal tendencies in certain individuals or of reacting rationally in the face of crimes already committed. This method of studying the genesis of crime involves rejection of the classical legal thesis which regards crime as a freely chosen manifestation of 'ill-will', but acceptance, on the other hand, of the view that crime is a natural effect of certain biological characteristics in an individual which cause him to react to certain external stimuli by committing criminal acts.

If we adopt the aetiological approach to the problem of crime, we have to identify the type of behaviour of which crime is but one special aspect, defined by the law and constantly modified by social evolution and the moral reassessment of various forms of human conduct which such evolution entails. Criminal law, at bottom, reflects that reassessment; certain types of conduct, previously regarded as socially inoffensive, are at a given juncture looked upon as harmful, and the penal laws are therefore extended to cover them; other forms of behaviour, formerly considered harmful, are no longer deemed such and gradually disappear from the penal code. Thus for example, under the Swedish criminal code, the penalization of adultery, homosexuality among adults, sexual relations with animals and certain kinds of abortion was abolished at the turn of the century, while other forms of behaviour, previously regarded as harmless, have become liable to penalties.

MALADJUSTMENT

The principal cause of crime is social maladjustment, which may be defined as the inability, in varying degrees, of an individual so to react to the stimuli of his environment as to be in harmony with it.

Whenever the brain receives an external or internal stimulus, its balance is slightly upset; and this in its turn sets in motion certain stabilizing mechanisms, which vary according to the nature of the stimuli and tend so to arrange the sequence of cerebral phenomena as to restore the balance by an appropriate terminal reaction. Should the balance not be restored, the terminal reaction becomes a stimulus entailing a further loss of balance. Maladjustment is thus a series of interconnected reactions which consume an individual's cerebral energy to no purpose and disturb the whole mechanism of his personality. It takes the form of a tension between the individual and his psycho-social environment, which often makes it difficult for him to earn his living and brings him into conflict with the community to which he belongs, or with society in general. Very often his maladjusted attitude provokes hostile reactions, of varying intensity, from the outside world; this tends to increase his isolation and deprive him of the moral support which conformity with his community would give him.

Under the influence of modern sociology, and more particularly of its Anglo-Saxon exponents, it has become almost axiomatic to attribute social maladjustment and criminal behaviour to harmful mesological influences, such as inadequate education, lack of affection at an early age (especially on the part of the mother), so-called mental traumatisms, and demoralizing influences in immediate surroundings. It is easy to understand why this particular way of explaining maladjustment has found favour with social psychology. Firstly, the latter studies, not the individual as such, but inter-individual or group reactions. Secondly, in trying to comprehend the motive for other people's actions, it is natural to consider the external circumstances in which a given act has been committed; although these are easy to see, it is not necessarily easy to define them accurately or to estimate correctly their influence upon the individual concerned.

It is a simple matter to draw up statistics on the number of disunited families, on bad physical and mental health conditions, on quarrels with other members of the family, employers or fellow-workers, etc., for a given group of maladjusted individuals. It is infinitely more difficult to assess the influence which these circumstances have in fact had upon a given individual within the group. That requires a knowledge of the individual's personality; but such knowledge is very hard to obtain, and is indeed accessible only to a very few people. However accurate statistics on mesological factors may be, they cannot explain the behaviour of an isolated individual. Moreover, it never happens that every single individual exposed to a certain number

of unfavourable external conditions succombs to their bad influence. Each individual who, in such conditions, succeeds in preserving his social and moral balance proves that the mesological circumstances of the case are not in themselves enough to explain lapses on the part of other members of the group. Some individuals, then, are completely impervious to the influence of certain factors in their surroundings, while others are very sensitive to them. This contrast is explained by the structural differences between individuals; and the causes of a crime cannot therefore be determined without making a *clinical study of the criminal's personality, both as a whole and in its special features.*

RELATIONS BETWEEN AN INDIVIDUAL AND HIS ENVIRONMENT

It would be outside the scope of this study to give a detailed description either of the psycho-social factors which are considered to foster social maladjustment and therefore to sow the seeds of crime, or of the social measures which are believed to help in preventing crime. It is, however, worth while dealing here with the nature of the relationship between an individual and his environment. As already indicated, the stimulus value varies, and the variation is between 0 and 1. Stimulus value means, for our purpose, the quantitative strength of mesological factors considered as stimuli, i.e. as factors capable of setting in motion reactions of the organism. As we have shown elsewhere (Kinberg, 1935; Kinberg, Inghe, Riemer, 1943), an external event never affects two people in identically the same way. If, for example, an honest man finds himself in a situation where he can appropriate a large sum of money without any risk of discovery, and this opportunity of acquiring wealth leaves him totally unaffected, it may be said that, so far as he is concerned, the situation has a stimulus value of approximately 0. In his place, an adroit thief would snatch the treasure without the slightest scruple and disappear in the twinkling of an eye; for him, that particular situation would therefore have a stimulus value of approximately 1. Thus it is not, as the proverb says, opportunity that makes the thief; it is, in Garofalo's words, opportunity that shows who *is* the thief.

It is also well known that an individual, up to a point, always selects his own environment. A confidence trickster is always attracted by crowds, where he thinks he will easily find people to take in; a cheat is drawn to gambling dens, a libertine to places of debauchery, etc. Honest people, on the other hand, are repelled by such places. It can therefore be said that the more an individual's bio-psychological make-up differs from that of the average man, the more he is both sensitive to the stimuli of certain specific surroundings and resistant to those of others.

Sometimes the reaction of such deviating individuals to special surround-

ings appears as a highly-developed flair, which enables parasites or criminals to recognize potential victims instantaneously. In one case we noted, a young and very pretty Danish girl—a music-hall singer—was walking one day with some friends in a park in Stockholm and noticed an old gentleman sitting on a bench. After glancing at the man, she apologized to her companions and went and sat beside him. The old man, who was suffering from senile dementia, was extremely depressed and inclined to be tearful. The singer engaged him in conversation and accompanied him to his lodgings, where she started to weep and told him a pathetic story about her penniless and friendless situation. Eventually, by working on his feelings and sexual instincts, she extracted from him some 45,000 crowns (£3,000 or $8,400) over a period of nine months (Kinberg, 1952).

When criminals are questioned about their past, they often plead that they have been influenced by 'bad company'. There are, of course, situations in which an individual is obliged to live in a psychological atmosphere which may be deleterious (prisons, for example). In that case it is difficult for him, in the long run, to resist pernicious influences. Nevertheless, I have come across people who have lived for over twenty years in prisons without being in the least affected, so far as one could see, by such influences.

Among people who are more or less free to choose their environment, one often notes a sort of instinctive process of selection which leads certain maladjusted individuals to seek out 'bad company'. Thus a young German —an accountant in a small town—after embezzling 10,000 marks and touring several European capitals found himself stranded in Stockholm. He knew nobody and could not speak a word of Swedish, but that did not prevent him from becoming a procurer the very day of his arrival. Two months later, with the help of a compatriot, he killed and robbed a postman carrying registered letters.

Such cases are an illustration of positive psychotropism, which is the expression of a general psychological law described by Maeterlinck in the following words: 'Whether you climb to the top of the mountain or go down to the village, whether you travel to the ends of the earth or take a walk round the house, you will meet only yourself on the roads of chance. If Judas goes out this evening, his steps will lead him towards Judas and he will have a chance to betray; but if Socrates opens his door, he will find Socrates asleep on the threshold and will have a chance to be wise.'

No man can escape human bondage. If, as some people assert, ordinary external circumstances were capable of turning anyone into a so-called neurotic, sane people would be extremely rare; fortunately, however, this is not the case. It is true that the sanest and most balanced of men may, under the shock of a great disappointment or sorrow, become anxious, nervous and depressed. With time, however, he grows accustomed to the new situation, recovers his mental balance and reverts to his former state,

except that his personality has been enriched by new experience. If, on the other hand, a person's individual reaction is obviously out of proportion to the circumstances which have caused it, if it drags on or becomes chronic, there is reason to believe that the basis of this abnormal reaction is an unfavourable constitutional alloy, a congenital pathological weakness of the brain, or a brain lesion.

This way of considering relations between an individual and his environment leads to the following conclusions:

1. The extent to which the environment can act as a stimulus, setting human reactions in motion, depends upon the personality of the individual.
2. Mesological factors alone do not cause mental illnesses or serious maladjustments. When an abnormal reaction is produced by unfavourable social factors, which are nevertheless frequently found and common to mankind in general, it can be assumed that the cause is either a constitutional weakness or some sort of brain lesion.

BIOLOGICAL ASPECTS OF THE AETIOLOGY OF CRIME

Before the causes of a crime can be ascertained, a thorough clinical examination must be made of all the component parts of a delinquent's personality, as it existed not only at the time of his crime but during the years preceding it.

Current studies of this kind have been greatly facilitated by a theory of Professor H. Sjöbring, of Lund University (1913, 1919). According to his theory, there are, among the countless human variants, some which are normal or evolutive, and others which are produced by brain lesions, or are regressive. The first group is composed of features which are the expression of normal and hereditary characteristics to be found, in varying degrees, in all men. These characteristics which I have called 'constitutional radicals', form the constitutional and normal nucleus of the human personality (Kinberg, 1941). In order to make things clear, the term 'constitution' and its derivatives will be applied only to variants of this first group. The use of 'psycho-pathological constitution' and similar terms causes confusion which must and can be avoided. If a man limps on account of a fracture of the fibula which has not healed properly, it would be ridiculous to say that he is suffering from constitutional lameness. By thus limiting the use of the term 'constitution', useful emphasis is laid on one characteristic of constitutional variants, namely *that they depart very little from the mean value of a group of variants*. Experience in the field of biology fully bears out this theory.

The result is that, every time a variant diverges too much from the average, it cannot be regarded as a normal or natural variant, but must necessarily be a pathological one. It is due either to an abnormal, hereditary charac-

teristic which is not included in the group of genes possessed by all men but is found in a few individuals only, or to some infection, intoxication, trauma, etc., which has affected the organism at some stage between the fertilization of the ovum and the point of development reached at the relevant time. With progressive recognition by psychiatrists of this extremely important distinction, the classification of mental diseases will inevitably be recast.

According to this view, the human constitution includes an unlimited number of variants, composed of a small number of 'constitutional radicals' in varying doses. It is mainly this fact, together with the additional pathological variants found in some individuals and the reactional modifications produced by mesological stimuli, that explains the infinite variability of man.

Since maladjustment often precedes crime, all the personal characteristics liable to lead to various forms of maladjustment should be reckoned among the individual causes of crime. As has already been said, from the standpoint of physiology of the brain, the reactions of normally adjusted people can be regarded as a series of cerebral phenomena set in motion by the stimulus and ending with a reaction which restores cerebral balance. Every brain factor tending to prevent the re-establishment of the balance may therefore help to create maladjustment, and therefore criminal tendencies. In psychological terms, it may be said that all individual factors which prevent a human being from understanding his environment (men and events), and encourage grabbing, aggressive or destructive instincts, tend to create states of maladjustment and, consequently, a leaning towards crime.

Heading the list of factors liable to produce such effects are certain extreme constitutional alloys. A short account of Sjöbring's constitutional theory is necessary in order that the meaning of 'constitutional alloy' may be appreciated. According to him, constitution (in the sense indicated above) is made up of four basic factors, namely: *capacity,* i.e. the maximum level of intelligence which an individual can reach under the influence of the most favourable mesological conditions; *validity,* i.e. the quantity of cerebral energy possessed by an individual; *stability,* indicating the ease with which an individual's emotional balance can be restored by means of cerebral processes; and *solidity,* indicating either the extent of functional unity of the brain, or, on the contrary, the tendency towards dissociation.

As all these radicals may vary continuously and independently of one another, all individuals are divided up, in regard to each of the four radicals, on a curve which may, theoretically, be assumed to be a Gaussian curve. So far as capacity is concerned, for instance, Roberts, Norman and Griffiths (1935) consider that the distribution of the intelligence quotient IQ (which is an essential element of capacity) among children of a given age-group follows a Gaussian curve, where the mean is 100 and the standard deviation 15. Galton's research (1862) led to the conclusion, confirmed by Pearson and

Jaederholm (1914), that the distribution of intelligence in a population might also be expressed by a Gaussian curve. It is therefore justifiable to consider as abnormal any cases situated twice as far from the mean as the standard deviation. It follows that, if 100 is taken as the mean IQ and 15 as the standard deviation, all cases below 70 and above 130 would be abnormal. According to the diagrams of certain research workers, in a population of 100,000 individuals, there would be 2,560 with an IQ lower than 70.

The other constitutional radicals—validity, stability and solidity—can probably also be expressed in the form of a Gaussian curve. As no method of measuring these radicals objectively has yet been discovered, it has been impossible to prove this by experiment. However, clinical observation confirms the theory that these radicals are similar in character to capacity, i.e. normal, hereditary, and present in variable quantities in all human chromosomes. It is thus reasonable to assume that they vary continuously and that the number of combinations is therefore unlimited.

The nature of each constitutional radical can be indicated by the prefixes *super, meso* or *sub,* according to whether the quantity in which it is found is excessive, average or insufficient. Every radical existing in a quantity above or below the average shows a group of characteristic structural features corresponding to a given pattern of predominant reactional tendencies.

Thus a *supercapable* individual (C+) is intelligent, keenly perceptive, responsive, sensitive, witty and very adaptable. A *subcapable* (C—) is stupid, unresponsive, narrow-minded, coarse and sluggish.

A *supervalid* (V+) subject is quick-witted, expansive, enterprising, resolute, full of initiative, calm, self-assured, persistent and ready to assume responsibilities. A *subvalid* (V—), on the contrary, is over-cautious, finicky, industrious, tense, unsure of himself, anxious, and afraid of taking any initiative or responsibility.

A *superstable* (St+) individual is emotionally cold, elegant, lacking in depth, clever, abstract and industrious in the realm of ideas. A *substable* (St—) is warm-hearted, interested in people and tangible things, hard-working in the practical field, ponderous and clumsy.

A *supersolid* (So+) individual is slow, staunch, steady, prudent, objective and deliberate, whereas a *subsolid* (So—) is lively, restless, changeable, pleasant, subjective, of narrow outlook, sometimes a liar, and very apt to break his word.

It is easy to see that an individual who is subcapable, supervalid, superstable and subsolid—and whose predominant characteristics are therefore stupidity, enterprise, lack of consideration towards his fellow-men, boldness, emotional coldness and a tendency towards impetuous and thoughtless actions —will be inclined to have ill-adjusted reactions. This constitutional alloy also implies underdevelopment of the moral function, which further reduces his resistance to criminal impulses.

Generally speaking, constitutional alloys deviating from the mean show a high degree of sensitivity to certain psycho-social stimuli, which varies considerably according to the nature of such stimuli. The range of this variation is very great, so that a stimulus may have no effect on one subject, while exercising an irresistible influence upon another. The stimulus value may also vary considerably in respect of the same individual if his resistance to the stimulus in question (or to a group of stimuli) is accidentally increased or lowered (for example, under the influence of certain toxic agents, alcohol, etc.).

MASSIVE BRAIN LESIONS

Apart from the question of constitutional alloys, any pathological change in the brain which attacks the general function of personality tends to disturb, not only the organism's internal functioning, but also its external activity.

In estimating the degree of pulsion towards the commission of offences, it might be assumed that massive and extensive brain lesions, the classical vesania (for example, general paralysis, senile or arteriosclerotic dementia, mental aberrations due to infection or intoxication, schizophrenia, etc.), were the principal causes of crime. Yet this is not so—probably because such forms of illness are relatively easy to recognize and have alarming symptoms, so that those affected are quickly removed to mental hospitals. If they sometimes manage to commit crimes before being confined, the fact that they are mentally ill is often so obvious that the authorities decide to abandon legal proceedings. Among the many delinquents whom I have examined at my clinic or elsewhere, the proportion of those suffering from massive brain lesions has always been very small.

NON-VESANIC FEEBLE-MINDEDNESS

The majority of subjects examined are, therefore, non-vesanic. There is quite a large number whose principal characteristic is mental deficiency, sometimes combined with morphological deformities (e.g. mongolism, microcephaly, cretinism and other malformations due to endocrine troubles of foetal injuries) or with other signs of brain lesions. According to Penrose (1949), such nervous disorders may be due to various influences: physical agents (X-rays on the embryo); nutritional factors, which, according to Murphy (1947), are liable to produce malformations through lack of calcium, phosphorus and vitamins B, C and D; infections (syphilis, German measles, toxoplasma, etc.); maternal sensitization, for example when a woman who is Rh negative becomes pregnant with a foetus which is Rh positive; maternal age (for instance, the increased danger of mongolism or congenital hydro-

cephaly when the mother is over 38 years of age at the time of pregnancy); and lastly, traumatisms of the brain caused by birth and the suffocation of foetus or newborn babies.

Of all forms of mental deficiency, with accompanying disturbances of intellectual or other functions, those resulting from harmful gene mutations in forbears are of no interest from the standpoint of the prevention of crime, for there is as yet no way of curing them and they can be only slightly modified by eugenic treatment. Prophylactic measures can be taken, on the other hand, in the case of brain lesions due to intra- or extra-uterine injuries (such as the foetal malformations mentioned above and forms of encephalitis and meningitis resulting from virus or bacterial infection), as well as of the various lesions due to intoxication, etc.

SMALL BRAIN LESIONS

So-called 'psychopaths' form another important group of delinquents subject to mental examination. In my opinion, this term, invented in the nineteenth century, should have been dropped long ago. At the Congress of Psychiatrists held in Copenhagen in 1946, we proposed its elimination from scientific terminology, emphasizing that it did not indicate the nature of the pathological states which it was supposed to define, that it was clinically vague and ambiguous, that it was not based on a penetrating psychological and clinical analysis such as it was possible to make at the present stage of scientific development, and that it consequently gave an incomplete and false idea of the states which it was supposed to indicate. It encourages mental laziness and hinders the clinical and scientific progress of psycho-pathology.

Many attempts have been made to describe so-called psychopaths. According to a short account by Curran and Mallinson (1944) of the basic characteristics of psychopaths, different authors give different descriptions, of which some very instructive ones are the following:

According to Levine (1940), 'psychopaths are "not normal", i.e. not mature, of good health and adjustment; not psychotic; not neurotic (although they may develop neurotic or psychotic symptoms); not necessarily feeble-minded; they live in a greater degree than is healthy in terms of short-term values of the pleasure principle; they tend to solve their life conflicts by overt behaviour'.

According to Hall (1941), their characteristics are 'egocentricity, inability to profit by experience; emotional instability; lack of perseverance; unreliability and irresponsibility; defective judgment; suspiciousness'.

Cleckley considers them to be attractive in appearance, clever, ready of speech, attaching no importance to truth or honour, bereft of all sense of shame, lacking in feeling, and betraying sexual abnormalities.

According to F. Darling (1945), Cleckley has defined 'psychopaths' as psychotics masked by '*persona*', i.e. a 'mask of health' dependent upon a deficient super-ego caused by a partial Oedipus complex. It would be rather difficult to find a less meaningful description of a psychopathological state.

Such descriptions, which juxtapose moral, social, clinical, characterological and mythological terms and quite often contain negative or contradictory features, give very little useful information and leave the clinician in doubt as to the nature and actual clinical symptoms of the states concerned. Going beyond these descriptions, I have tried to analyse so-called 'psychopathic' states and to classify them in accordance with pathological syndromes and the nature of the factors which cause them.

Following this system of classification, we have first of all a group of individuals whose constitutional alloy is composed of variants deviating considerably from the mean value. These are meso- or supercapable, supervalid, superstable and subsolid persons who may, under certain mesological influences, show the well-known characteristics of crooks, swindlers, confidence tricksters, hoaxers, etc. The 'professional thieves' group described by Chis Conwick (1950) seems to have a constitutional alloy of this kind. Although the condition of these individuals is not morbid, it differs sufficiently from the mean to give them a leaning towards crime, which is favoured by the administrative and political structure of North American society.

Sometimes the alloy of subcapacity, superstability and supersolidity, combined with certain brain lesions, produces ascetic, inflexible or phantasmatic personalities, such as Jehovah's Witnesses, for instance, who may become conscientious objectors (Uddenberg, 1946).

Another group consists of subjects with sexual abnormalities due to hormonal causes, especially true homosexuals. Other dysmorphisms (eunuchoidism, gynecoidism, infantilism, etc.) are also to be found in this group.

A third group consists of states formerly called 'epileptoid states', 'epilepsia larvata', 'epilectic habitus', etc., which are now designated by the general term of 'ixophrenia' (Strömgren, 1936, 1940)—from the Greek *ixós* (lime for catching birds)—owing to the sticky, slow, ponderous and tenacious character of the cerebral activity of those afflicted. Their attention cannot easily be distracted; they cling to their ideas, are continually repeating themselves, are prosy, persevering, often obstinate and vindictive. Owing to the nature of their emotivity, they cannot easily distinguish between shades of meaning; although their intelligence quotient may be good, they do not grasp the essence of problems and find it difficult to understand human beings and events.

Ixophrenics undergo continually emotional charging and, when the curve reaches a certain height, the internal tension is relieved by an emotional outburst. In cases where such characteristics are very marked, the outburst

may take the form of real fits of rage, accompanied by acts of violence and destruction. Owing to their tendency to have exaggerated or desperate reactions, ixophrenics are greatly predisposed to suicide (Dahlgren, 1945). They are also prone to depression, particularly if their constitutional alloy contains the radical of substability. As they are often irritated and dysphoric, they easily develop paranoia. They are also inclined to fight against their dysphoria by means of alcohol. Their dangerousness[1] is sometimes greatly increased by the fact that they are prone to fall into states of pathological drunkenness, with deep mental obnubilation and fits of rage. Most alcoholic 'wife-beaters', and the majority of those who murder out of jealousy or under the influence of alcohol, seem to be ixophrenics. According to certain writers, there is a relationship between epilepsy and ixophrenia, and ixophrenic caracteristics are very often, if not always, found in epileptics.

To sum up, the nature of their cerebral activity renders such subjects hypersthenic, passionate and not very scrupulous, and predisposes them to emotional storms—at which times they are extremely dangerous. Among them are to be found certain monstrously cruel and violent individuals who owe their sinister fame to the many murders they have committed. The following case was recorded in a small village in Southern Sweden.

The Case of John

John was a young country policeman of 25, engaged to a social worker employed in a home for the aged. When going for a short drive with him one day, the girl, having noticed his excessive violence of character, took the opportunity to tell him that she no longer wished to marry him. In spite of her fear of John's violent reactions, she agreed to meet him in his bedroom on the night of 19 August 1952. They had no sooner entered the room than he threw her on the bed, took her in his arms and squeezed her so hard that she cried out in pain. Having failed to gag her with his handkerchief, he forced his closed fist into her month, tearing the corners of the mouth and damaging the pharynx. Taking advantage of her semi-conscious state, he then handcuffed her. It was only after much pleading and praying on the girl's part that he removed the handcuffs, threatening her with worse to come if she made the slightest sound. After this savage scene, they spent the night together.

The next morning the girl—who was in a pitiful state, her face and pharynx injured and her body covered with bruises, barely able to speak, and quite unable to eat—consulted a doctor. The latter did his best to persuade her to complain to the police, but she was too terrified to do so. The doctor therefore took it upon himself to inform the police. Having admitted the facts, John was immediately discharged from the police force. Three days later, he killed his parents with an axe and set fire to their house. He then went to the home for the aged where his fiancée was living and, pushing his way into her room, murdered her with the same axe. He also killed the directress of the institution in the same way, after which he set fire to the building. Out of the 17 inmates, four were burnt to death, and three others later died of their injuries. After this massacre, which took place between midnight and two o'clock in the morning, John drove in a car to a small lake, where he drowned himself. He had previously drawn up a statement giving an account of his crimes, including a murder with theft and arson committed in the neighbourhood several months earlier.

1. A definition of this term, which is commonly used in criminology, will be found further on.

The Public Prosecutor, who had enquired why John's fiancée had not been better protected, was told that John had not seemed so dangerous; that he had never uttered any threats; that his brutal treatment of his fiancée had not been sufficiently serious to warrant his arrest; and that, in any case, they had been reconciled immediately afterwards, since they had spent the night together. It was even pleaded that individual freedom should be protected against misuse of the power of the law. Lastly, as if such a drama were not horrible enough without a final comic touch in doubtful taste, on the very evening of John's murder the villagers held a meeting and expressed the wish that he should be allowed to keep his job in the police force.

Comments

A few days after the first murder, which he seems to have committed with the utmost sang-froid, John purchased a motor-car. As a policeman, he took part in the preliminary enquiry, during which his stupidity betrayed him into some unwise actions which nearly caused him to be suspected. There are some curious details connected with the events that took place between 19 and 23 August: the incident of the handcuffs on the nineteenth, and the self-accusatory statement on the twenty-third, both reminiscent of police methods, here applied in a strange, pedantic way.

In his confession, John gives as an excuse for his parents' murder the fact that he wished to spare them the suffering his intended crimes would have caused them. Thus the stupidity of this subcapable, supervalid and ixophrenic individual, whose first murder proved that he would stop at nothing, prevented him from solving his sexual problem in a normal way. It is a well-known fact that some sexual experiences, coupled with the usual powerful emotional charging, strengthen the tendency towards emotional storms, which may then reach the extreme destructive pitch characteristic of ixophrenics in particular. The continual emotional charging of ixophrenics may perhaps act as an amplifier, making the emotions usually caused by appropriate mesological stimuli abnormally and dangerously violent.

A fourth group of sufferers from small brain lesions, often also described as 'psychopaths', consists of flabby, indolent, lifeless and feeble individuals. This syndrome, owing to some of its features, resembles Pierre Janet's 'psychasthenia' syndrome, which has been well known for a long time. These subjects are the very opposite of ixophrenics. On account of their flabbiness and feebleness, it has been proposed that they be called chalarophrenics, from the Greek *chalarós,* signifying flabby, spineless, feeble (Sjöbring, 1952). Serious cases are emotionally irresponsive or only slightly responsive; they are cold, indifferent to the fate of others, lacking in affection for their own family, and incapable of feelings of friendship and solidarity. That does not, however, prevent them from having a tendency to seek out their own kind and form criminal gangs. Owing to their lack of endurance and tenacity, they do not adapt themselves well to any kind of work, and this is apt to

lead to difficulties with their employers and fellow-workers. Their movements are sluggish, often jerky and exaggerated, they have very little muscular elasticity, their imitative powers are poor and their faces are often at once flabby, hard and cold.

From the point of view of intelligence, they vary a great deal, but even those with an adequate intelligence quotient are incapable of taking advantage of it. They are inconsiderate, thoughtless, scatter-brained and improvident. They often commit crimes in such a stupid way that they cannot fail to be caught; when questioned, they say that they had not thought of the consequences of their acts.

Their dangerousness is not of the same kind as that of ixophrenics. As they find it difficult to provide for their material needs, their favourite offences are against property (thefts, embezzlements, etc.). However, as their moral function is underdeveloped on account of their very slight capacity for emotion, they do not offer much resistance to the impulse to resort to violence (armed robberies, burglary with violence). The bio-psychological mechanism of their acts of violence is, however, quite different from that of ixophrenics. With the latter, it is their passionate attitude towards the outside world—the result of cerebral hypertension—which makes them liable to have extreme, violent and destructive reactions. With serious cases of chalarophrenia, on the other hand, it is lack of any real understanding of the outside world (which, notwithstanding a good, or even high intelligence quotient, always seems to them to some extent foreign, distant and unsympathetic), emotional coldness and defective or insufficient moral development that make them, in varying degrees, deaf to moral considerations.

There is a theory that ixo- and chalarophrenic states are probably due to lesions of the white matter in the region of the large thalamic nuclei. This would explain why a mixture of ixo- and chalarophrenic symptoms is often to be seen in one and the same individual. Such individuals are feeble, inactive, flabby, asthenic and cold, with a low level of what is known as 'reality feeling', and suffering from moral deafness, i.e. a lessening of 'responsiveness to moral considerations'. From time to time, however, they may be subject to emotional storms caused by special circumstances, such as bouts of alcoholic intoxication, sexual experiences, fits of jealousy, etc. The following is an example of such a case.

The Case of Peter

A workman, 32 years old, alcoholic and ixophrenic father, irascible mother. A brother who had committed suicide. From the age of 6 to 7 years, was difficult, intractable, hard and violent. At school, found no difficulty in learning, but was aggressive, erratic and shirked his duties. Later, when in employment, was withdrawn, uncommunicative, and periodically lazy and nonchalant. From the age of 20, became idle, careless, irritable and started to live on his family. Was several times convicted for inflicting blows and wounds; poured boiling coffee on his mother's arm and punched her in the

head; hit his father over the head with a stick and punched him in the eye. At the age of 24, married and had two children. Although not an alcoholic, after drinking he was like a madman, crying and moaning like a child, swearing and using obscene language with his wife, etc. Sometimes threatened to kill his children. Often hit his wife and was extremely jealous. After seven years of marriage, his wife obtained a separation. As a result, Peter's violence increased; he threatened to shoot her with a revolver, forced his way into her house and tried to strangle her. Finally, after torturing her mentally and physically for a very long time, he stabbed her to death. The examining specialist declared him to be hysterical, schizoid and explosive, but not mentally ill. Was condemned to life imprisonment. After a few months, was transferred to the psychiatric section of a prison. He was then declared to be schizophrenic. A few months later, as he was extremely dangerous, he had to be shut in a special section of a lunatic asylum.

Comments

What is striking in this case is the contrast between the man's ordinary attitude—inactive, spineless, ineffective and lazy—and his sudden and violent fits of irritable emotionalism, caused by more or less unimportant external circumstances and culminating in the murder of his wife. Here, as in John's case, it is sexuality that causes the final emotional eruption and precipitates the tragedy. Hyper-sensitivity to alcohol and proneness to fits of pathological 'drunkenness' are also to be observed in this case. The word 'hysteria', so often used indiscriminately by doctors and laymen to indicate any irascibility, is certainly also applicable here. It may therefore be assumed that many ixophrenics have so-called hysterical characteristics.

The mistaken diagnosis given by the psychiatric section of the prison and the asylum was in strict contradiction with the symptoms shown by Peter for over twenty years. This mistake was made because ixo- and chalarophrenics have not been sufficiently studied and knowledge about them is inadequate. The fault, however, also lay in not making a clinical analysis and failing to apply the principle that, in order to understand human behaviour, the whole of the human personality must be studied.

It is obvious that the group of so-called 'psychopaths' have other syndromes of which little or nothing has been known hitherto. There are, for example, the aberrant personalities of drug addicts, those suffering from traumatism, and those who are hyper-sensitive to changes in the internal humoral medium, such as subjects in whom a lowering of 20-30 per cent of the sugar content of the blood, or hyper- or hypoxemia (excessive or insufficient oxygenation of the blood) may cause disturbances in the cortical rhythms (which can be discovered by means of an electroencephalograph EEG), accompanied by a lowering of the faculty of judgment and by states of mental obnubilation (Hill and Sargent, 1943).

THEORIES ON SYNDROMES OF SMALL BRAIN LESIONS

When we began, thirty years ago, to observe many syndromes of this kind, we were inclined to think that subjects who were neither afflicted by massive brain lesions (classical vesanics), nor mentally defective or imbecile, belonged to a large group whose brains were malformed owing to hereditary pathological tendencies (gene mutations). However, the idea that such abnormal individuals were injured, in the widest sense, was not a new one.

Over fifty years ago, one of Lombroso's associates pointed out that, among so-called constitutional criminals, there was a group of individuals with a serious deficiency of the moral function due to lesions of the brain (Audenino, 1896). A few years later, Lombroso, Ferrero and other research workers of the positivist school described cases of cerebral traumatism among children, followed by moral deficiency. P. Hartmann (1910) and others have emphasized the fact that cerebral traumatisms may entail mental disorders, limited to varying degrees of moral deficiency. In many cases which we studied, most of them criminals (Kinberg, 1930, 1935), we found a number with signs of various brain lesions (lethargic encephalitis, cerebral traumatism, ixophrenia, mental disorders following influenza, post-pneumonic encephalitis with epilepsy, etc.). The two following cases are quoted to illustrate the nature of the syndromes of certain individuals suffering from small lesions of this kind.

The Case of Daniel

Workman, aged 20. When 11 years old, had a severe attack of pneumonia with violent mental confusion. Remained in bed for a month and a half. Two years later, a further attack of pneumonia, also with mental confusion, during which he threatened to kill his mother. At the age of 15, localized cramps in the face and right arm, followed by a severe epileptic fit and deep sleep. At 16 years of age, German measles, at 17 years of age, influenza. After staying in bed for a week, he returned to his work and had a fainting fit. On the evening of the same day, another attack of double pneumonia with mental confusion. After the attack, remained weak and dysphoric for several months. Grew nervous and anxious, and took to going out and getting drunk, which he had never done before. Began to speculate on the stock exchange. Was dismissed from his employment, but did not tell his parents. Started to wander aimlessly about the streets, slept badly with agonizing nightmares, fits of mental anguish starting with headaches, even during the day, and sometimes accompanied by fits of violent rage.

A few months later, his health improved and he took on a new job; misappropriated funds and was dismissed. As his parents paid up the money which he had embezzled, he was not prosecuted. Was then apprenticed to a gardener to learn gardening. At the age of 18, had a further attack of pneumonia, when he was nursed by the gardener's wife. When he had recovered, she made advances to him to which he responded. However, she was exacting, which exhausted him and made him nervous; he no longer dared to sleep, for fear that she might come and importune him again. In order to escape from these nocturnal visits, he often used to go for a walk instead of sleeping. One night when she came in, he scrambled out of the window to escape from her. When he returned a few hours later, she was still waiting for him. In a fit of anger, he pushed her out of the room, but she came back a little later. When he was

struggling to get her outside, she screamed for help, which made him still more furious. He seized his razor with the intention of cutting his arm, but, as she tried to stop him, the blade slipped and cut his jacket. The other gardeners, having heard the woman's shrieks, came running up. At the sight of them, Daniel was seized with another fit of rage. He threw them out of the room, followed by his shoes, a table and various other objects, after which he closed the door and went to bed. He was confined for a week and then put to work on a farm. But he was bored, and, one day, irritated because his parents had asked his employer to withhold his salary, he burgled a shop, was convicted and given a suspended sentence. He was then 19 years old. A year later, he was again confined. He had robbed his parents, threatened to kill them, had attacks of mental anguish, headaches and bouts of insomnia. According to his mother, he had fathered three illegitimate children by different mothers. He had had an affair with a maid-servant, passed himself off as a wealthy gentleman and had robbed and swindled the family for which his mistress was working. At the asylum, he was indolent, spineless, flabby, irritable in spasms, emotionally and morally cold, indifferent about his reprehensible conduct, etc.

He was discharged from the asylum at 22 years of age, his parents having undertaken to exercise close supervision over him. Five years later, Daniel's father informed us that all was well; his son had found steady and well-paid employment and was working most satisfactorily. Now he has been married for several years and looks after his wife and children. He loves his home, never goes out and has lost all his old craving for pleasure. He is affectionate and extremely considerate to his parents. In fact, he has reverted to what he was before his attack of pneumonia at the age of 13 years.

Comments

This case shows how ordinary infections like influenza and pneumonia repeatedly produce encephalitic syndromes with local symptoms, such as very occasional cramps and epileptic fits. In addition, the patient quite often has attacks of mental anguish, headaches and fits of anger, which might be considered as epileptic equivalents. Still more important from the criminological standpoint are the marked signs of a profound change of personality with frequent threats and acts of violence, thefts, embezzlements, snatch-and-grab robberies, etc., testifying to polymorphous social maladjustment. This subject thus shows a mixture of chalarophrenic and ixophrenic characteristics—so-called hysterical tendencies (tendency to commit snatch-and-grab robberies) —and a marked lowering of the moral function. Cramps and sporadic epileptic fits indicate the existence of a localized lesion, and perhaps of active scars, i.e. scars giving out impulsions which hinder the cerebral processes from restoring the balance referred to earlier.

A further interesting point is the tendency, in a previously abstemious subject, to absorb excessive quantities of alcohol. As an explanation of his surprising and unexpected recovery after the syndrome had lasted nine years, it might be assumed that the brain scars were gradually transformed until they ceased to be active, whereupon the normal cerebral processes were restored.

The Case of Ernest

Quarryman, 37 years old, depressive tendencies in both parents. Was subcapable and slow. Had an epileptoid fit at the age of 12. His sexual life was normal. When 37 years old, had an attack of influenza. A few months later, he felt flat and depressed, slept badly, felt an urge to prowl, stayed away from his work in order to wander about outside the small town in which he lived. His brain became muddled and, although he knew the country well, he had difficulty in finding his way home. In one year he was guilty of 17 rapes and several attempted rapes. Among his victims were a little girl of 14 and two girls of 16 and 17. He had attempted to rape another little girl of 14. Some details of his behaviour are indicative of his attitude towards his victims. To one woman who resisted him, he said: 'Silly creature, I don't want to hurt you, but I must have a woman'; and, if the woman continued to struggle against him: 'If you don't hold your tongue, I'll kill you.' He often tried to allay his victims' fears: 'Don't be afraid, I don't want to do anything dangerous to you. A hussy wouldn't be afraid of that!' His sentence was remitted and he was put into an asylum.

A medical examination showed him to be slightly microcephalic, without marked mental deficiency. He was nervous, depressed, easily frightened, slightly obnubilate, and tearful. He only partly remembered his acts. At the asylum, he was calm and hard working. After four years, he was released and resumed his former life. He no longer shows any signs of maladjustment or criminality.

Comments

In this case, a slightly subcapable and subsolid man—who had previously led a well-adjusted life, apparently without showing any criminal tendencies or committing any criminal offences—suddenly developed a confusional syndrome as a result of influenza caught during the great epidemic of 1918-19. As the clinical description supplied very little information, it is probable that the clinical picture was fuller than that description would lead one to suppose. At all events, the main point is that a peaceful and well-adjusted man develops, as a result of influenza, a confusional syndrome which manifests itself in repeated rapes, and that, after a time, he recovers and becomes once again the peaceful, hard-working and well-adjusted man he was before he experienced his attack of influenza.

These two cases, observed during the 1920's, have been singled out from those of a great many individuals, previously sound in body and mind, who developed criminal tendencies as a result of cerebral traumatism, encephalitis lethargica, and encephalitis following common microbian infections (influenza, pneumonia, exanthematous fevers, polyarthritis with chorea, etc.). There was a case of a young man who had been treated in hospital for tubercular meningitis and had recovered; upon returning home, however, he began to show signs of maladjustment in the form of repeated acts of violence against his parents and sister. When sent to stay with another family, he behaved very well; but after returning to his own family he again became violent, and was arrested. The mental examination revealed no mental deficiency; he behaved excellently at the clinic. It was therefore his family environment alone that roused him to violence.

THE CONTRIBUTION OF SCIENCE TO THE DIAGNOSIS OF DANGEROUSNESS

Ever since Lombroso and his colleagues began to study the personality of the criminal in an effort to discover the reasons for crime, the idea of 'dangerousness' has taken a preponderant, central place in criminology.

Various definitions of dangerousness have been given but many of these are somewhat abstract and legal. If, however, we start from the fact that all human reactions—including crime—occur when the pulsion, or, in other words, the combination of individual and mesological factors tending to produce the reaction, is stronger than the resistance, we might say that 'dangerousness' is the state in which a given individual is placed when criminal pulsion tends to overcome resistance.

Dangerousness therefore involves both individual and mesological factors. But another group of factors pertaining to both the individual and the environment must also be taken into account—i.e. the moral atmosphere and the moral function.

It is obvious that the considerations on the relation between the subject and his environment set out above do not imply that mesological factors are of no importance in the origin of crime, but as these factors depend on the subject and are not objective in character, it is highly improbable that they can produce a state of mental sickness or lasting maladjustment in all subjects. For this reason, analysis of the personality of the subject as a unique entity is, in our view, the most important means of studying the aetiology of dangerousness. For this it is necessary to determine the constitutional alloy, to discover the aberrant mental functions and their causes, to clarify the condition of the moral function, and to show the interaction between the personality viewed in all its complexity and the combinations of individual and mesological factors responsible for the pre-criminal situation. We use this expression here to cover all the individual and mesological circumstances which are of special importance in the origin of any given crime, though they may not have immediately preceded it in time.

For the clinical means which help us to understand the complex shades of the criminal's personality we are principally indebted to the penetrating and original theory of psychological constitution, put forward by Sjöbring, and his discerning clinical observations carried out on persons suffering from small brain lesions. These have given us a detailed knowledge of the psychological mechanisms leading to crime and have provided a basis for the work of Swedish criminologists (Kinberg, Inghe, 1943; Kinberg, 1946; Gerle, 1946, 1953; Uddenberg, 1946, etc.).

Secondly, mention must be made of a series of observations proving that not only exanthematous fevers (scarlet fever, measles, rubella or German measles, etc.) and a large number of infectious diseases produced by viruses or bacteria (whooping-cough, mumps, poliomyelitis, typhoid, polyarthritis,

pneumonia, influenza, etc.) but also common infections of the respiratory tracts, the ear, etc., may lead to encephalitis, sometimes with so few symptoms as to be unperceived by the physician and those close to the patient. A steadily increasing body of observations indicates that even slight encephalitis often produces mental syndromes which may give rise to a state of maladjustment and to crime (Kinberg, 1930; Sjöbring, 1946, etc.). Analysis of these syndromes has given us a better understanding of the mechanisms leading to dangerousness and crime.

The contributions that electroencephalography (EEG) has made to the diagnosis of mental syndromes give grounds for great hopes. Firstly, it seems to be proved that epileptics show characteristic abnormal graphs. This is a particularly important point because many criminals are epileptics and it is sometimes difficult to prove the incidence of epileptic attacks when the subject himself declines to give information on this point. What is possibly even more interesting is the fact that the relatives of epileptics often show abnormal graphs (Harvald, 1950). It has also been found that aggressive or violent maladjusted persons show characteristic dysrhythmia (Walter, 1951).

By means of EEG it has also been established—and this is an important discovery—that there is apparently a connexion between murders for which there is no comprehensible motive and irregularities in the cerebral rhythm (Hill, 1950). The same author emphasized, in a submission to the British Royal Commission on the question of capital punishment, that certain subjects are very apt to lose their mental balance when exposed to stress, particularly of chemical origin. Forced breathing as a result of emotion, for instance, may increase irregularities in the rhythm of the brain.

Certain subjects are abnormally sensitive to minor hypoxemic conditions which have no effect on a healthy man. Cases have been observed in various countries in which criminal behaviour seems to coincide with hypoxemic conditions.

At the present time, efforts are being made to discover correlations between normal and abnormal cerebral functions and mental disorders. In several research centres in the United States of America, efforts are being made to perfect the EEG technique in order to enable us to study the rhythms of the central parts of the brain. Very fine electrodes are introduced into the brain to locate foci with an abnormal rhythm, to stimulate certain parts of the brain and study the effects of this stimulus, and to remove cerebral lesions by coagulating them electrically (Sem-Jacobsen, 1953).

To sum up, the object of all these efforts is to discover the physiological and pathological brain mechanisms responsible for normal psychological functions and various types of mental disorder, and to elucidate some of the causes of dangerousness.

MEDICAL ASPECTS OF THE MORAL FUNCTION

Moral values are associated with the spiritual atmosphere of society and do not concern us here. The moral function, however, is associated with personality, of which it is an integral part. We use this term to denote the capacity of individuals to assimilate and to adapt themselves to the moral values belonging to the spiritual atmosphere of the society in which they live. This capacity is not innate; it is the result of a gradual organization of the brain or, in psychological terms, of a habit slowly acquired, due to the influence of the environment on the biological structure of the brain. This development is explained, on the one hand, by certain qualities of the cerebral tissues which make the desired organization possible, and, on the other, by certain qualities in the environmental stimuli which set in motion the processes resulting in the necessary organization.

The result is that any deficiency in the brain tissues, whether hereditary or acquired, may either prevent the necessary cerebral organization or impede, pervert or even destroy an already established moral function. This fact has been proved empirically by clinical observations on subjects abnormal from birth and on mental patients. Again, 'cultural destitution' may hinder the development of the moral function in healthy individuals whose brain tissues are free from hereditary or acquired defects.

There is an abatement of the moral function not only in persons suffering from massive brain lesions but also in those suffering from small brain lesions. We have known for a long time, for instance, that all sorts of attacks on the brain by harmful agents (traumatism, encephalitis, acute or chronic intoxication, etc.) bring about a more or less serious abatement of the moral function. Even non-pathological conditions, such as intense fatigue or debility following some illness, may accidentally weaken the moral function, with sometimes grave results for the subject.

We have not sufficient space to deal in greater detail with the role of the moral function in the origin of crime (Kinberg, 1935, 1948, 1950, 1953). From the results of clinical work on the moral function in subjects with hereditary defects or suffering from a variety of cerebral lesions, however, we can say that, in all the cases studied, the *moral function played no independent part* in the origin of dangerousness and delinquency.

According to Sutherland and other American sociologists (1949), crimes can be explained by the hypothesis of 'differential association'. This hypothesis is that criminal behaviour is 'learned in association with those who define such behaviour favourably and in isolation from those who define it unfavourably and that a person in an appropriate situation engages in such criminal behaviour if, and only if, the weight of the favourable definitions exceeds the weight of the unfavourable definitions'. Other American sociologists, however, think that the personal traits of the delinquents must be

taken into account in order to explain the crimes considered by Sutherland (Clinard, 1946).

We shall confine ourselves to a brief criticism of Sutherland's hypothesis. If we accept it, we must regard man as a moral computing device whose individual variations in biological structure are literally conjured away. Man becomes a passive instrument utterly dependent on the moral 'definitions' of his environment at the time and has no chance of being influenced by groups and persons other than those in his immediate vicinity. Such a contention is in direct contradiction to our own, which is that criminology is a clinical science and that it is impossible to arrive at a causal explanation of crimes except by using the clinical method. In conclusion, we would stress that the thesis defended by Sutherland and others conflicts with the empirically established fact that the moral function of sufferers from massive and small brain lesions is more or less deaf and dumb.

CONTRIBUTION OF SCIENCE TO THE PREVENTION OF CRIME

As we have endeavoured to show, the normal structure of the personality, that is to say the algebraic sum of the dominant reactional tendencies, plays an important part in all crimes, and individual pathological factors play a preponderant part in most serious crimes. Scientific methods of preventing crime must therefore be directed, in the first place, to the *personality* of people who are in danger of developing into criminals and of those who have already committed crimes.

As the constitutional alloy is determined by normal hereditary factors found in varying proportions in all men, we have no means of changing it at will. If, however, its composition is such that it tends to favour maladjustment under the influence of certain mesological factors, detailed analysis of the delinquent's personality may help us to choose an environment conducive to his social readjustment.

In the case of a variety of malformations or lesions suffered during foetal life, certain preventive measures can be taken. From the observations made during an epidemic of rubella in Australia, described by Greggs (1941), it appears to be proved that, if the mother contracts rubella during the first months of pregnancy, the danger of cerebral and other malformation in the foetus is considerably increased. In such cases, it is advisable to avoid pregnancy for at least two months after the end of the illness (Sundal, 1953). Observations made by Ivstam (1951) show that, out of 261 cases of deaf-and-dumbness in which no reason for the affliction was known, in 12 per cent of the cases the mother had had rubella during the first four months of pregnancy. Because of the very considerable risk thus involved, Sundal considers it advisable to induce abortion if the mother has had rubella in the

first 8 or 10 weeks of pregnancy. The same author urges that great care should be taken when ACTH or cortisone is used during the first 12 weeks of pregnancy. It is also possible that hypoxemia in the mother may result in malformation in the foetus: 30 per cent of the mothers who had given birth to malformed children had a haemoglobin rate of less than 75 per cent (Worcester and others, 1950).

We may here mention a recent study (1953), carried out by Malmnäs, a Swedish obstetrician, on the causes of death in 815 cases in which the foetus died before, during or immediately after birth. This shows that, in about 75 per cent of the cases, the death of the foetus was caused by anoxemia of various origins. It is therefore probable that pre-natal or peri-natal hypoxemia not sufficiently serious to kill the foetus might nevertheless give rise to serious and persistent cerebral lesions. It has been known for a long time that peri-natal asphyxia is often followed by mental deficiency of varying types and degrees. A considerable number of cerebral lesions at the time of birth are also due to traumatisms. Another set of measures, quantitatively of much greater importance in the prevention of crime, relates to prophylaxis of lesions which may affect the brain after the birth of the individual. First and foremost in this field we have to consider direct and indirect injury to the skull.

It has been known for a long time that certain individuals have a constitutional or acquired tendency to suffer accidents, particularly accidents at work. A large number of studies on the frequency of accidents at work have shown that such accidents are not distributed evenly over the whole body of workers; three-quarters of the accidents occur to only one-quarter of the workers, and always to the same quarter (Elena Fambri, 1938).

In view of the relative frequency of all types of cerebral lesions and of the very important part they play in the origin of crime, it is obvious that medical prophylaxis of all the complaints which may produce such lesions is a measure of the very greatest importance in the prevention of crime. From this point of view, the prevention of crime in the individual is primarily a medical question involving, first and foremost, improved nosology to facilitate quicker and surer diagnosis of cerebral lesions (especially those found in persons suffering from small brain lesions, of which little is yet known), and, secondly, advances in preventive and curative epidemiology, for the daily increasing body of observations suggests that a great number of infectious diseases often affect the brain. What we have to do here is to discover the signs which foreshadow such attacks and to devise and apply chemical therapy for arresting infection due to viruses or bacteria at an early stage. Lastly, the medical prevention of crime also includes measures to combat forms of occupational proisoning (carbon monoxide, coal gas, halogens, etc.), drug-taking (morphine, cocaine, opium, etc.) and alcoholism.

To sum up, the contribution of science to the prevention of crime in the

individual covers any medical and scientific measures by which, firstly, we can prevent the birth of children with brains malformed, underdeveloped or showing lesions due to traumatisms or toxic or infectious agents, and, secondly, we can prevent children born normal and healthy from suffering any type of cerebral lesion.

As improved methods of diagnosis help us better to locate the lesions responsible for mental disorders, and as chemical or surgical treatment, in the widest sense of the term, helps us to remove or eliminate the lesions which obstruct the proper functioning of the brain, the present attitude towards the biological factors in crime, which is still passive and uncertain, will give place to more active and more effective therapeutic measures. Any means whereby man's cerebral health can be preserved or restored reduces the risk of maladjustment and thereby of criminality. Therein lies the great contribution which science can make to the prevention of crime.

LOCAL ENERGY SOURCES FOR UNDERDEVELOPED AREAS

by

E. W. GOLDING

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One of the great problems facing the present-day world is that of rendering less uneven the distribution of real wealth as expressed in terms of food, clothing and other amenities which go to make up the total requirements of civilized existence. The standard of living is inevitably different in different countries as it is in different sections within the same country. But, whereas a reasonably uniform standard can be attained in the latter case by social legislation, any significant levelling up on a world scale can only be brought about by international action.

The bald facts are that the population of the world is increasing at the rate of some 20 millions a year; more than half of the present population of 2,200 millions is definitely undernourished, and only one-third is really adequately fed. At the same time, only half of the land area is 'cultivated', while only one-third of this is devoted to food and fodder production. The remainder is covered by forests or is used to provide inedible raw materials. Thus, although there may remain disagreements on ideologies and on the methods which should be applied in national development, the fundamental problem of the increased utilization of natural resources to raise the general standard of living is universal; efforts to solve it are being made by the United Nations Organization and its specialized agencies such as Unesco, the Food and Agriculture Organization (FAO) and the World Health Organization (WHO).

THE UNDERDEVELOPED AREAS

First, let us consider what parts of the earth's land surface are underdeveloped and the reasons why they are so. There are, of course, two large groups of territories which immediately come to mind, namely, (a) the polar

and sub-polar regions, and (b) the arid and semi-arid areas, including the 'hot and cold deserts'; but, in addition, there are many areas having less obvious limitations which yet play little part in supporting man's existence. Among these are the high mountain ranges, the tropical rain forests such as the vast area of the Amazon basin, and the moorlands of northern Europe.

Climate has a very important bearing on the density of population and the degree of development of any region, but it is seldom solely responsible for the lack of population. Man is very adaptable and is capable of existing permanently almost anywhere in the world with the exceptions of the polar regions and the summits of the highest mountains. Thus, for example, we have the Eskimos and Laplanders living within the Arctic Circle and towns in Siberia where there are winter temperatures of 50°F or more below zero; the Sherpas, who played a considerable part in the recent conquest of Everest, actually live by farming at an altitude of over 14,000 feet in the Himalayas, and the capital city of Quito (Ecuador) stands at 9,400 feet, almost exactly on the equator. The world's deserts support a nomadic population, and primitive tribes inhabit the dense forests of Africa and South America. Nor is the climate alone a sufficient reason for some of these sparsely populated regions remaining uncultivated; botanical science has shown plant breeders how to produce strains capable of withstanding the conditions found in the sub-polar regions or in the arid or semi-arid zones. In the latter, indeed, the deserts have often been at least partially man-made. When, as part of the ancient Babylonian empire, the region between the Tigris and the Euphrates was covered by an efficient irrigation system it was rich and agriculturally productive. But in the course of time this system was destroyed or allowed to fall into decay, so that the wind and advancing sand have gradually effaced all signs of the ancient prosperity.

In many of the semi-arid areas vegetation has been destroyed by man either in his search for fuel for his fires or by his voracious herds of goats, so that, with nothing to bind it, the soil has blown away or has been washed away by the uncontrolled rush of water when occasional heavy rains have occurred. Given a fair start, some of these areas could re-establish vegetation cover without further aid.

Nevertheless, climate is one of the major causes of underdevelopment; extremes of cold or of heat, accompanied by low rainfall, place limitations on what can be grown. Rainfall is particularly important. No crops of any agricultural value can be raised without a water supply, and this may be costly to provide artificially. Too much rain, or rainfall badly distributed throughout the year, may give rise to both floods and soil erosion which can have worse effects than drought.

In mountainous and moorland areas the soil is often thin and poor in quality, calling for additional nutrients if agriculture is to be rendered practicable. In some semi-arid and even desert areas, on the other hand, soil

nutrients are not lacking but most economically valuable plants cannot utilize them without fresh, i.e. non-saline, water. The inhabitants of such areas are forced by these conditions to lead a nomadic existence, continually moving their grazing flocks to follow the random pastures which spring up after the occasional showers of rain occurring at widely scattered places. This mode of life inevitably precludes settlements and ordered development.

In other parts of the world where the climate is more favourable to plant growth, its effect, especially in warm or hot climates, may be such as to engender an easy way of life with indifference to the question of improvement through the fuller utilization of the natural resources. If cold and hungry, one is forced to work to exist, but there is no such pressure in a warm country where sufficient food, at least for bare existence, is obtainable without much effort. Pests and diseases play their part in hindering development, as for example in parts of Africa troubled with tsetse fly (whose bite is often fatal to domestic animals) and with malaria-carrying mosquitoes.

Ease of communication is another important factor, and a few countries have remained undeveloped mainly because they have no seaboard and are cut off by a difficult terrain from other centres of population. Nor must one overlook the political factor: lack of a stable system of government is often accompanied by a lack of incentive on the part of the population towards fuller development.

ENERGY RESOURCES AND NEEDS

One of the most valuable assets in any country, and one which has a very direct bearing on its development, is a natural source of energy, which may take the form of coal or oil or hydraulic potential. As a power producer, man himself is a poor thing. In the Guyol report[1] he is credited with one-twelfth of a horsepower, or 150 kWh of energy per year of 2,400 working hours; this is almost exactly the same power as that used for an electric reading lamp. A horse used for 800 hours a year would supply 600 kWh of energy.

The existence of an abundant source of energy has undoubtedly a most potent influence on material development. Professor M. S. Thacker[2] has shown that there is a very close connexion between the annual energy consumption per head of population and the various data which may be used as indices of development, such as annual income per head, or the consumption of food or of raw materials for clothing. 'In Europe today the

1. N. B. Guyol, *Energy Resources of the World*, U.S. Government Printing Office, 1949; see also: Sir A. C. Egerton, *Civilization and the Use of Energy*, Unesco/NS/74, Paris, 13 February 1951.
2. M. S. Thacker, *The Role of Energy in Underdeveloped Areas*, Unesco/NS/78, Paris, 24 May 1951.

pursuit of productivity, or of production per man-hour as it is sometimes called, is regarded as the royal road to economic solvency. . . . The immediate availability of power to a community is a measure of its prosperity, or potential prosperity.'[1]

In an attempt to define an underdeveloped country Kingsley Davis[2] has taken as a criterion the fact that 'more than 50 per cent of its gainfully occupied males are engaged in farming, hunting, and forestry. Such a country is still in the peasant-agricultural stage of economic development'. On this definition, three-quarters of both the world's population and its inhabitable area are embraced by the term 'underdeveloped areas'. Davis also shows that peasant-agricultural regions have a high density of male agricultural workers per square mile of farm land—an average of 113 as compared with an average of only 32 in 'modernized' countries.

The provision of energy to assist man in his labours, agricultural or industrial, through mechanization of the processes involved, must be accepted as an essential requirement for economic development. How is this energy to be provided?

Clearly, with so large a total area to be considered, there is no single answer to this question. In the first place let us consider the resources at our disposal. These can be divided into two classes—the 'irreplaceable' and the 'replaceable'. In the first class are the solid and liquid fuels: coal and lignites, peat, petroleum, natural gas, shale oil, and materials providing nuclear power. Among the replaceable sources are wood, vegetable and animal wastes, non-tidal water power, tidal power, wind power, solar radiation, internal heat in the earth.

A. Parker[3] has reviewed these various resources and, by taking the annual rates of exploitation, has estimated the 'life' of those in the first class. His couclusions are that 'the reserves of solid fuels (mainly coal) are sufficient for 1,000 or 2,000 years or possibly longer, but that the reserves of oil and natural gas, even allowing for the discovery of additional resources, may not last for more than 50 or 100 years'. He considers it impossible to give useful estimates of atomic energy resources, but states that the technical difficulties and costs of producing energy by this means make its use for ordinary requirements on a considerable scale unlikely within the next fifty years. If fully utilized, wood, and vegetable and animal wastes could provide the equivalent of about a quarter of the present annual production of fuels, while non-tidal water power could generate electrical energy equal to about one-third of this production. Only some 4 per cent of the water power potential

1. The Earl of Verulam, J. Houston Angus and S. Chaplin, 'The Geography of Power: Its Source and Transmission', *The Geographical Journal*, vol. CXVIII, pt. 3, September 1952.
2. Kingsley Davis, 'The Controversial Future of the Underdeveloped Areas', *World Population and Future Resources*, edited by P. K. Hatt, New York, 1952, chapter 2.
3. A Parker, *World Energy Resources and Their Utilization*, The Thirty-sixth Thomas Hawksley Lecture, The Institution of Mechanical Engineers, London, 1949.

has so far been developed. Tidal power schemes, though they would be important locally, would not make a significant addition to the world total.

The conventional sources of energy—fuels and water potential—are already easy and cheap to use; it is not therefore surprising that they have been exploited much more fully than such sources as wind, solar radiation and terrestrial heat, which have scarcely been tapped. Yet, although the techniques required for the economic utilization of these latter resources have not been completely worked out, they are all being investigated and their potentialities are enormous.

F. E. Simon[1] has stated that 'about 2 per cent of the sun's energy falling on the earth is converted into energy in the form of wind' and, although only a small fraction of this could conceivably be captured, an annual energy equivalent to some 1,500 million tons of coal might be made available from this source. Parker estimates that, if one-tenth only of solar radiation could be retained, it would be equivalent to the energy of 17 million million tons of coal a year, while Simon has stated that an area the size of Egypt, if used to convert solar radiation directly into usable form, could supply the world's present needs for power. As to the energy stored in the earth as heat, it may be equivalent to 80 million times the reserves of coal.

If the thermal value of the food required, representing about 10 per cent of the annual energy consumption, is included, the present rate of utilization of energy is equivalent to 3,000 million tons of coal a year. This represents an average of 1.4 tons for each person, whereas the consumption in the United States and in Great Britain is about seven tons and four tons respectively. Taking energy consumption as a mesure of the standard of living, these figures give eloquent testimony to the low standards in many other parts of the world.

THE DISTRIBUTION OF ENERGY RESOURCES

On first consideration, reserves of the world's energy resources, which can cater for the needs of many centuries to come, appear satisfactory enough to remove any anxiety for the future, even if we neglect the inexhaustible sources which have not yet been used to any appreciable degree. But this is not a true picture of the situation. There is the all-important question of the cost —of winning, or capturing, these supplies, of converting them into usable forms, and of distributing them to the places where they are needed. Energy resources are by no means uniformly distributed over the world; some countries have ample resources which are more than sufficient for their present needs, while others have very few. For example, Africa possesses about

1. F. E. Simon, *Energy in the Future*, Unesco/NS/79, 5 February 1951.

40 per cent of the world's potential water power and North America 49 per cent of the coal reserves, while Australia has less than 4 per cent of the water power and South America under 1 per cent of the coal.

The question of transporting energy is important both nationally and internationally. Thus, in Sweden, where water power is abundant, some of the major sources are situated five or six hundred miles to the north of the industrial centres which need the power, so that these sources have remained unused until quite recently. The technique of electrical transmission at very high voltages has now been mastered well enough to enable the power to be brought south economically over this great distance. The advantages of energy in electrical form lie mainly in the relative ease with which it can be transported and in its great adaptability to many different purposes. Hence the present tendency to think of energy mainly in electrical terms.

The location of energy sources often presents problems of development, the solution of which may have a great influence upon the economy of an area or of a nation. Many illustrations of this could be given. For example, at the Kariba and Kafue Gorges on the Zambesi river and its tributary the Kafue in northern Rhodesia, there is a hydro-power potential of some 1,250,000 kilowatts, and schemes have been formulated to develop it. But the distance of the sites from any industrial centres which could utilize such a large quantity of power has forced upon the sponsors of the schemes the inclusion of a complementary one for the initiation of a large metallurgical industry founded on the local availability of ample cheap electrical energy. The development of this potential will thus involve the establishment of a new industry where there was none before and will attract a considerable population to a district which is now but sparsely inhabited. Another illustration can be taken from Norway, where the problem of using the large water-power resources is attended by another: Is it better to increase Norwegian industrialization on the basis of hydro-electric power, or to export the power for other countries to use? Power exports to Sweden, and to Denmark, which has very few energy resources, are now economic possibilities through high-voltage transmission, while under-sea transmission to Great Britain may soon be feasible through the development of high-voltage direct current. On the other hand, Norway can use its abundant water power to produce calcium carbide and to transform alumina into aluminium, the export of which may cost less in transport than would the power itself.

Interchange of electric power between countries already takes place, of course, especially over the international grid network in Europe, and further interchanges are planned, but both economic and political considerations limit their scope. However, the discovery of a new oilfield can also transform the economy of a country almost overnight, while its precise location may, again, raise the question of whether it is more advantageous to export the oil or to use it locally.

But whereas solid and liquid fuels for power production may have to be transported at a considerable or even prohibitive cost, while hydro-electric power stations, stations using terrestrial heat or natural gas, and the power plants which may utilize differences in temperature at various depths in the sea must all be located in the immediate vicinity of their source of energy, two other sources—wind and solar radiation—are much more widely distributed and offer the advantage of not necessitating any transport either of the fuel consumed or of the energy produced. They can be exploited locally but there are the accompanying disadvantages that they are not continuously available and that the machines or other apparatus needed to capture them may be expensive. Both the power plants and the techniques of using these energy sources need careful study—which they are indeed receiving at present in several countries—to determine how far they can be used economically in competition with energy from other sources which may have to be imported at considerable cost.

To summarize the present state of the world's needs and resources, food supplies are inadequate and should be doubled or trebled within the next few decades if the rapidly increasing population is to be saved from near-starvation. The world-wide standard of living could be raised by applying scientific methods of cultivation to increase food production per acre, and by doubling or trebling energy supplies. The world's energy resources are adequate; what is needed is their widespread development and distribution, and the education of the inhabitants of underdeveloped areas in the full and most effective use of this energy.

PLANS AND DEVELOPMENT SCHEMES

An all-powerful world authority responsible for development of energy resources in the best interests of the entire population might proceed as follows:

1. Institute careful surveys to determine accurately the magnitude of the energy resources in their different forms.
2. Decide which of these forms should be exploited immediately and which conserved for limited use over a long period of years.
3. Fix the order in which the power schemes should proceed so as to give the best geographical distribution in relation to the numbers of inhabitants and to their needs.
4. Relate the developments to one another so that they would be complementary and not require an excessive amount of power transmission from one district to another.
5. Arrange for the education of the inhabitants so that they could both create and use to the best advantage their own power plants with such assistance as might be needed from other regions.

6. Undertake research aimed at improving present methods of energy development and utilization and at discovering new methods.

In the absence of such a supreme authority there cannot in the immediate future be any complete control and ordered development; education and persuasion must therefore be used to accomplish the necessary steps towards a fuller satisfaction of the world's needs. But even our imaginary authority could not bring this about in a short time owing, above all, to the limited supply of competent skilled manpower. In any case, exploitation of energy resources must in the main be undertaken nationally with economic and technical assistance from international bodies, such as the United Nations Organization and its specialized agencies, and from organizations such as the World Power Conference.

Hydro-power resources, particularly where they are fairly near to centres of population, so that power transmission is not unduly costly, are already being developed in countries which are not industrialized or which are even classed as 'underdeveloped'. Thus we have the Owen Falls scheme for 150,000 kilowatts in Uganda which is under construction, a series of hydro-electric stations in Greece which will eventually feed a grid network, and a plan to construct hydro-schemes in Nigeria on the Niger river, and on the Volta river on the Gold Coast. India has a total hydro-power potential of between 30 and 40 million kilowatts, of which only some 7 or 8 per cent will have been utilized when some of the new plants under construction come into operation in 1955. That these are badly needed is clear from the fact that the total installed capacity of electrical generating plant in India is under 10 kilowatts per 1,000 inhabitants as compared with some 300 kilowatts per 1,000 in Great Britain. It is worth noting also that the projects under consideration by the central, provincial and state governments in India will provide irrigation for some 20 million acres as well as giving about 5 million kilowatts of extra electrical generating capacity. On the Nile, in Central Africa on both the Zambesi and the Congo, and in Pakistan, Brazil and many other parts of the world there are schemes for hydro-electric power generation and for irrigation which, when completed, will have far-reaching effects in the countries concerned.

In addition to developments of the power of rivers and lakes, which, though often costly, are still within the compass of their sponsoring governments, there are others of even greater magnitude which have had to be shelved for lack of capital, or for the want of an economic outlet for the power they would provide. There have been technically feasible schemes for power generation by leading sea water from the Mediterranean to the Dead Sea—over 1,200 feet below sea level—or into the Qattara Depression in northern Egypt which is some 500 feet below sea level.

THE NEED FOR LOCAL ENERGY DEVELOPMENT

But valuable as they are, all these hydro-power projects have their economic limitations. Often they are located so far from areas which could be brought into fuller use for agricultural or other purposes that transmission of power to those areas and, in addition, distribution to a scattered population, would be very costly. In time, as development proceeds and new areas are enabled to support a much greater density of population, transport of electric power from outside, or of fuel carried over new communication lines, will become economically possible. Without entering into a detailed discussion on the costs of transporting energy in different forms, it may be sufficient to point out that electrical transmission lines to carry power over long distances—when the voltage used must be high for economy—may cost anything between £5,000 and £10,000 ($14,000-$28,000) per mile, while even the cost of lower-voltage distribution lines for local supplies is in the range of £500 to £1,500 ($1,400-$4,200) per mile, depending upon voltage and capacity and upon the form of construction. Again, the cost of fuel for diesel engines is often doubled or even trebled by freight charges for a journey of three or four hundred miles from port or railhead.

Much must depend upon the plan adopted for development, but it is fair to assume that, initially, it will seldom be feasible to provide full services of water, electricity or other forms of power from an outside source. Thus, newly established communities may have to be mainly self-supporting, at least in the early stages of development. The same applies, of course, to established but isolated communities, such as those on islands remote from supply centres.

Local resources—in the strictly limited sense of the word—may therefore assume considerable importance, and this fact lends particular interest to the investigations now in progress on the possibilities of such energy sources as wind, solar radiation, peat and waste vegetable matter. All of these sources have, in the past, presented some difficulties in exploitation—otherwise they would already be in much wider use—but there are now much better prospects for their economic utilization, provided that there is sufficient effort on the part of the investigators, and patience and co-operation on the part of the potential users. No worth-while projects of this kind are ever brought to a successful conclusion without enthusiastic work and thought, tempered perhaps with a little optimism; certainly no progress is made by sitting still and counting the difficulties which may have to be faced.

LOCAL RESOURCES

Local sources of energy vary widely according to geography and, even more, to climate. But one has to distinguish between the special and the general cases; there may, in an underdeveloped area of appreciable size, be a few places where a small amount of power could be generated from deposits of low-grade fuel, from wood or, perhaps, from hot springs. These may be sufficient only for the use of communities on the spot, and they would thus be inadequate for the general development of the area—unless they were of frequent and widespread occurrence.

There are, however, some resources which exist commonly enough for their utilization on a much fuller scale to be envisaged. Among these, wind, solar energy, and vegetable wastes are perhaps the most important. Peat and small water-power sources are others which, though not in quite the same category, could sometimes be dealt with in the same way. The characteristics of these energy sources as potential power producers differ and may be outlined briefly as follows.

Wind Power

Wind power has the advantages of being freely available and inexhaustible, and of being usable without occupying any appreciable area of land for the purpose and without being detrimental to adjacent areas. It is widespread in occurrence, especially on islands, in coastal regions, and at well exposed sites inland if the district is not screened by high mountain ranges. Its annual average speed is surprisingly regular, year after year, so that the total energy which may be obtained from it annually by a machine of a given size is also regular.

Its main disadvantages are (a) that it cannot be depended upon with certainty to produce power at any particular time even at the windiest places in the world (although in some regions the expectation of wind during, say, the afternoon throughout some seasons of the year is high), and (b) that wind-driven machines must be relatively large (and therefore relatively expensive) for a given power capacity because of the low density of the air, which implies a small amount of kinetic energy per unit of volume.

The power ouput of such a machine is proportional to the product of the air density (in pounds per cubic foot), the area swept by the revolving rotor, and the cube of the wind speed. Thus, a high wind speed has a great effect upon the power for a given swept area, since it enters into the power expression as the cube of its magnitude.

If adequate wind records for a site are available, one can calculate accurately enough how much energy could be obtained during the year from a wind power plant of given capacity operating through a selected range of wind speeds. It would be uneconomic to attempt to use winds of all speeds

in the same machine, so that the design of the machine is based upon the wind speeds which occur most frequently. Maintenance costs for wind-driven plant have been found to be generally low, so that one has to consider mainly the charges for interest and depreciation.

From wind power studies which have been made in Great Britain,[1] supported by wind data from other parts of the world, it appears that the other elements of annual wind régimes at different places are sufficiently similar—in so far as they affect the operation of wind power plant—for the annual average wind speed at a particular site to be used as a measure of the annual energy obtainable from a machine of a given size and design. Thus, for example, a wind-driven electric generator designed for use in areas which are only moderately windy will produce, for each kilowatt of its capacity, 1,900 kWh annually at a site with an average wind speed of 12.5 m.p.h., 2,700 kWh for 15 m.p.h., and 3,500 kWh for an average wind speed of 17.5 m.p.h.

For windier sites, machines generating their full power output at a higher wind speed—and therefore having relatively smaller and cheaper rotors—can be used to provide the same annual amount of energy per kilowatt, while, conversely, larger and more expensive machines will be needed for places with lower wind speeds.

What is the lowest average wind speed which can be used economically? To this question there is no single answer. All depends on the circumstances at the site considered. If the power plant, to be located at a place having an average wind speed of 12.5 m.p.h., costs £150 ($420) per kilowatt of its capacity, and if the annual charges are 10 per cent, this gives an annual cost of £15 ($42) for an annual output of 1,900 kWh, i.e. a little less than 2d. (slightly more than 2 cents) per kWh. This may seem to be expensive until one considers that the alternative method of power generation by, say, a diesel engine can cost nearly twice as much for fuel alone if the location is remote so that transport charges are high.

The operation and installation of wind-driven machines will be discussed later, but it is worth mentioning here that many thousands of small sets for the supply of electric light to isolated individual premises are used in various parts of the world, while others, of high enough capacity to cater for the needs of small communities, are now appearing on the market at a price which should prove economic under a wide range of conditions. Larger plants suited to the power demands of more populous groups are being developed and there is good reason to suppose that, assured of an adequate demand, the manufacturers could also make these cheaply enough for their use to be practicable.

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1. E. W. Golding and A. H. Stodhart, *The Selection and Characteristics of Wind Power Sites*, Electrical Research Association Report, Ref. C/T108, 1952; and E. W. Golding, *The Utilization of Wind Power in Desert Areas*, Electrical Research Association Report, Ref. C/T110, 1953.

Solar Radiation

It happens that many underdeveloped areas, and particularly those which are desert or semi-desert, have an abundance of sunshine; if means could be devised to capture directly, without prohibitive cost, the energy provided by solar radiation, the problem of power supply, at least during the daytime, could be solved. The rate of heat supply from the sun to the outside of the earth's atmosphere has an average value of 1.35 kilowatts per square metre of surface,[1] although that reaching the ground cannot be taken as averaging more than about 0.15 kilowatts per square metre. The actual value varies of course with the latitude of the place considered, with the time of year, and with the degree of cloudiness during the day.

The utilization of solar power for specific purposes, such as water heating, space heating, air conditioning, cooking and water distillation, is quite possible and has indeed been tried experimentally with some success by a number of investigators, some of the work on the subject having been done centuries ago. The difficulty encountered is again economic rather than technical, because of the large collecting surface which is needed. The maximum efficiency of collection is probably about 60 per cent, so that at least ten square metres of surface are needed to achieve a power of 1 kilowatt.

Mirrors are used to concentrate the sun's rays when high temperatures are required, as for cooking or for heating in a furnace, but this concentration is not economic for low temperatures. The Indian National Physical Laboratory has developed a solar cooker which, with a heating power of some 400 watts, can cook a meal of rice for four people in about half an hour. It is of simple design and is to be made commercially for use in Indian villages. Research sponsored by the French Government at Mont-Louis in the Eastern Pyrenees has led to the development of a furnace in which mirrors are used to give a concentration of some fifty thousand times the normal radiation and so to produce temperatures around 3,000°C.

The possibilities of the use of solar energy are being studied experimentally in the United States, U.S.S.R., Israel, Britain and elsewhere, as well as in India and in French territories, and it may be expected that the difficulties will be sufficiently overcome for at least some limited applications to be made in the near future. Technically it is possible to convert solar energy into electrical power directly by the use of thermo-electric couples, or by photo-electric or photo-galvanic cells, but the efficiency of such conversions is very low and the prospects of its improvement in the near future are not bright.

Power production by a steam, vapour or hot-air engine supplied with

1. 'Utilization of Solar Energy', *Research*, Report of the National Physical Laboratory Committee, November 1952.

solar heat concentrated by a mirror collector is also technically possible, although the low efficiency obtainable—and the consequent high cost per installed horsepower of the engine—suggest that some other solution to the problem might give better results.

Growing plants utilize sunlight by photosynthesis very efficiently, and it is argued in the National Physical Laboratory report that the best way of using solar radiation as source of energy might be to grow wood which could be used as fuel in a small steam engine of high efficiency. It is shown that this method would be superior in output per acre to that employing animal power with the animal's food being obtained from the same area of land. A small steam engine and boiler which can be fired by wood or by other forms of vegetable matter is being sponsored in England by the National Research Development Corporation and, if this can be made in sizes of up to about five or ten horsepower at a sufficiently low cost, there is little doubt of its great scope as a power unit for small-scale use—especially in parts of the world where other fuels are expensive through high transport charges.

One must not allow pre-occupation with the question of using solar radiation for power generation to obscure the necessity of increasing the utilization of solar energy for the production of food, which is of course the fuel for the human motor. An interesting possibility which now presents itself, following research which started in the United States some six years ago and which has just been fully reported,[1] is the culture of unicellular algae, particularly *Chlorella* species, for food rich in protein. The advantage of this form of culture is that an area of land can be kept green with plants throughout the year with a daily harvest, so that the maximum use of the sunlight is made through photosynthesis; the annual yield of food per acre is thus much greater than that from other agricultural crops. There is a need for further studies to determine the best means of puting to use economically, in large-scale algae culture, the results of the research made in America, Great Britain and elsewhere. Some such studies have, indeed, begun.[2]

Wood and Vegetable Wastes

One cannot draw any precise distinction between this class of fuel and solar radiation from which it is derived; it has already been mentioned that an effective way of using this radiation is through the medium of photosynthesis. It is estimated that about half the world's annual production of wood is used as fuel, giving a thermal equivalent approaching that of 400 million tons of coal. There are, in fact, 5.5 million square miles of accessible forests which can provide wood at the rate of about 20,000 cubic feet per square mile per

1. *Algal Culture from Laboratory to Pilot Plant*, Carnegie Institution, Washington, 1953.
2. H. Gaffron, 'Food from Algae', *Research*, June 1953; and M. J. Geoghegan, 'Unicellular Algae as a Source of Food', *Discovery*, December 1953.

annum, giving an annual total of 110,000 million cubic feet per annum. The total forest area of the world is however some three times as large and there is thus a possibility of at least doubling the annual production if other forests could be exploited commercially. There is, however, a limiting factor when wood is used as fuel; its bulk means expensive transport, so that it is usually burnt close to its source. Nevertheless the planned utilization of wood as fuel could assist in the improvement of some underdeveloped areas.

This is even more true of vegetable and animal wastes, such as sugar cane wastes and dung. In general it would be out of the question to transport these fuels over any appreciable distance, but they can be used advantageously on the spot.

Peat

Like wood, peat constitutes an important source of thermal energy which, in the main, is used locally; but unlike wood and the other vegetable wastes just mentioned, it is an 'irreplaceable' source of energy. Although surveys of the world's peat deposits are incomplete, it is probable that the total reserves are of the order of 120,000 million tons (allowing for a 25 per cent moisture content). These are located mainly in Europe and North America.

Peat-burning power stations are, of course, no novelty. They have been in use in Russia for more than twenty years and are now being built in other countries. In Ireland the first station, of 25,000 kilowatt capacity and burning some 120,000 tons of peat per annum, was opened in 1950; two more stations, each of 40,000 kilowatt capacity, have since been built. The calorific value of peat of 30 per cent moisture content, at 6,200 B.T.U. per lb., is about half that of coal. The main difficulties to be faced in this method of power generation are the costs of winning the peat and of drying it under the unfavourable climatic conditions which often exist in districts where it is found. Again, an extensive peat bog is needed to justify the expenditure for a power station.

During the last few years more detailed surveys have been made to determine the depths of the bogs and the quality of the peat in different areas (peat, instead of being burnt as a fuel, can be used for producing waxes). In Caithness (northern Scotland), an experimental station is to be established using a peat-fired gas turbine for power generation. In the Huleh district in Israel there are deep deposits of papyrus peat which, however, has a rather high ash content and may prove to be more useful for agricultural purposes than as fuel. Often peaty moorlands are useful only for sheep grazing or for afforestation, but there is some prospect of improving their agricultural value by removing the surface peat for fuel and uncovering better land below.

INTERMITTENT POWER SUPPLIES

Supplies of power generated from coal or oil or hydro-electric plants for industry and for large urban communities must be continuously available; they are so available—except, perhaps, at times of exceptionally heavy load (when power cuts have been found necessary in recent years because of shortage of generating plant), or when rainfall is unusually low in districts depending on hydro-electric power. But in the underdeveloped areas which we are considering, something much less than one hundred per cent dependability in the power supply may be acceptable. An intermittently available source of energy—like wind or solar radiation—judiciously applied, would certainly be a great improvement on the present situation when there are no power supplies and no prospect of their being provided economically from outside the area concerned.

Briefly, the position which must often hold in such areas is that the energy available annually from local sources—wind or solar radiation or small water courses, or wood and vegetable wastes, or perhaps even a combination of two or three of these—would meet the needs of a population large enough to undertake the initial stages of development of the land for agriculture or for small local industries. But, although the annual total of energy may be adequate, its availability at any particular time is unpredictable. The problem is, therefore, to devise both equipment and techniques of operation capable of providing a power supply which is as continuous as possible, without incurring excessive cost for either the power-generating machine or the energy-storing devices associated with it. There are good prospects of suitable power plant being developed cheaply enough, but storage of energy in sufficient quantity to cover all requirements during times when power is not being generated is potentially expensive; it may double or treble the cost of the energy provided.

To take an example, the writer recently made some estimates of the costs of wind-generated electrical energy for a community in a remote area where the annual average wind speed was supposed to be not very high—only 12.5 m.p.h. Taking the energy at random, as it became available from the wind, the cost was 1.85d. (2.15 cents) per kWh, but when the annual charges on a battery of accumulators to give only a limited amount of storage (covering essentials such a lighting) were added, the overall cost of the energy rose to 3.46d. (4.03 cents) per kWh. An alternative way of stating the case, based on the actual figures in these estimates, would be to say that the stored energy cost 9.48d. (11.0 cents) per kWh, and the unstored, or random, energy cost 1.85d. (2.15 cents) per kWh.

This greatly enhanced cost is brought about by the high price and short life of the electric battery. Comparable costs were calculated for power generation on the same site by diesel engine, and these showed a fuel component

of about 3.4d. (4.03 cents) per kWh (total cost 4.46d. or 5.2 cents per kWh). If it were possible for this community to use a diesel engine as a stand-by plant, it would therefore be cheaper than a battery, but the wind-power plant would be used whenever there was sufficient wind. To summarize this case, random energy from the wind is cheaper than that generated by a diesel engine, but the 'firm' (or 'on demand') energy provided by the battery is dearer.

Much the same applies to other methods of storage when equipment has to be provided for no other purpose than to hold back energy until it happens to be needed. But the form in which the energy is eventually to be used greatly influences the matter. Some uses for energy demand no fixed time-schedule; they can absorb it as and when it occurs, and therefore constitute loads with inherent storage. Water pumping is an instance of such a load. Within the broad limits set by the minimum quantity of water needed to supply normal daily demands, on the one hand, and the maximum storage fixed by the capacity of the tank or reservoir, on the other, it matters little when, or at what rate, the pumping is done.

Thermal storage may take several forms—water heating or steam raising, heat storage blocks for cooking or space heating, space heating from the latent heat of crystallization of certain substances which are melted when heat is available, water distillation, refrigeration, or soil heating for horticultural purposes. In some of these uses the storage period may have to be short if it is to be efficient; in others, e.g. distillation, the product of the heating can be stored for a long time.

The number of conversions of energy from one form to another affects the cost considerably; the fewer the conversions the better. Thus, if solar radiation can be stored as heat in a hot-water or latent-heat system, the losses of energy involved will be small, provided the storage period is short. But if there are to be several intermediate forms of energy between the original form and the final one, both losses of energy and costs of equipment are likely to be heavy. Thus, for example, a scheme which has some attractions, since in effect it could provide a locally manufactured fuel, is to use wind-generated electricity to electrolyse water to give hydrogen. This hydrogen can be stored indefinitely for use as a fuel for heating or cooking or driving an engine, but unfortunately the process of passing through several conversion stages would not be very economical.

It is clear that the best use can only be made of these random sources of energy if some 'planning' is done. The word has, one fears, an ominous ring but there is a fair prospect of some of the planning being done automatically by the power installation itself. It would seem by no means impossible to change over automatically from one source of supply to another, or from one use to another, in accordance with availability or need. For example, with a wind power plant generating electricity, water pumping could perhaps

be a basic or stand-by load to be supplied when the wind power was not needed for other purposes. After a period of pumping long enough to provide water for the immediate future, the plant could be switched over to water heating or to another of the storage loads.

The installation itself certainly calls for careful thought, especially in combining the different sources of energy which might exist at the site concerned. Some loads are more suited to one form of energy than to another. Thus, a wind-electric plant may be best for lighting, or a wind pump for water pumping, while water heating might be done better by solar radiation, and steam-raising by the burning of vegetable wastes. Some of these purposes, e.g. water heating, could be served alternatively by all three of the sources mentioned.

It would, of course, be fruitless to attempt to plan without a knowledge of the magnitudes and times of availability of the various resources which could be called upon. And it is equally necessary to know how much energy, in what forms, and at what times, will be needed. These two aspects—availability and utilization—are complementary, and it cannot be too strongly emphasized that both must be studied fully if the application of local energy resources for development is to be a success.

ENERGY SURVEYS

For fairly obvious reasons information on the local resources in underdeveloped areas is often either scanty or not in the form required for a proper assessment of the possibilities. Thus, surveys of an area scheduled for development will usually be necessary. Meteorological records taken by the nearest observation station and covering a long period will doubtless serve as a guide, but only as a guide. It is very difficult to generalize, but records of temperature and of hours of sunshine may be taken at a station some distance away from the area considered, as they do not differ greatly over the whole area. But wind speeds and rainfall vary so greatly from point to point that detailed surveys, particularly of the former, are essential.

The precise location of the measuring site, both in itself and in relation to the surrounding terrain, is very important in wind measurements. Avoidance of screening by trees, buildings or nearby high ground is an obvious requirement, but even more important is the choice of a site where the local wind speed is higher than that for the surrounding district. In wind surveys made in Great Britain, most of the selected measuring sites (over 100 in number) have been located on the summits of fairly steep and smoothly shaped hills. These are not necessarily of great height, but their shape is such as to accelerate the wind flowing over them. Thus, in districts where the annual average wind speed is (say) 15 m.p.h., favourable sites have been found with

average speeds of between 20 and 25 m.p.h. This means that the energy obtainable from a wind rotor of any given size, located at the chosen site, would be at least double that for the district generally. The economic importance of this increase in energy, due merely to a proper choice of site, can easily be appreciated.

A wind survey for the especial purpose of determining data for wind power in an extensive area need not be expensive if it is made with some knowledge of what is to be expected. Thus, at a small number of typical sites anemometer recorders giving hourly wind speeds should be installed, so as to enable the wind régimes to be measured in detail. The velocity-duration curves for the sites (i.e. curves giving the annual number of hours during which the wind speed exceeds any given value) can be drawn, and from these the annual wind energy available for a given size of wind rotor can be calculated. At other sites in the area, it will be sufficient to instal much simpler and cheaper counter anemometers which measure merely the total run-of-wind in miles. The annual energy at these places can be estimated accurately enough by comparing their annual average wind speed[1] with that at the locations of the recorders. The changing of the recorder charts should be made at weekly of fortnightly intervals by a semi-skilled person, but the readings of the counter instruments can be taken by anyone who can read figures.

The measurements mentioned will provide a basis for energy estimates and will guide the choice of site, but some further information is needed from the measuring stations. Thus, in order to judge what provision in needed for storage of energy, it is important to know what total periods of calm, or of winds too low to be usable for wind power, are to be expected, how frequently these periods occur and at what seasons of the year. Again, the duration and frequency of occurrence of very high wind speeds, as well as the actual speeds, should be determined for the benefit of the designer of wind-power plant as well as for the potential user. Obviously, the more the windmill manufacturer knows about the behaviour of the wind in the areas where his machines are to be used, the greater the possibilities of a design suited to the particular conditions. For this reason, information on gust speeds and on sand storms or other local phenomena would be very useful.

As for the design of plant for the utilization of solar radiation, it is probable that regional records of the intensity and duration of the radiation are already known well enough, without the need for local measurements for this specific purpose. A knowledge of local conditions might however be useful to ensure that these do not differ so greatly from the regional ones as to necessitate modifications in the design of the equipment.

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1. Average wind speed $= \frac{\text{miles of wind}}{\text{hours}}$.

Surveys of energy resources in the form of vegetable or animal wastes would involve local studies and enquiries rather than scientific measurements, but accurate determinations of the quantities likely to be available at specified times, and of their thermal characteristics, are important if their utilization is to be properly planned.

In studying local materials which might influence the provision of energy, two subsidiary, but nevertheless important, questions should be borne in mind. These are, first, whether any of the materials found locally could be used for the construction of crude but effective power plant, such as the simple windmills with rough wooden frames and reed mat sails used by the Chinese peasants for pumping water or brine. 'Machines' of this kind could not be used to provide any significant amount of energy for the general development of an area, but they might make a small contribution towards the establishment of new settlements and would, at least, introduce ideas on power utilization which at a later stage could be followed up by more efficient machines of larger power capacity. Secondly, it would be well to take account of the effect which the use of considerable quantities of vegetable matter or of animal wastes as fuel might have upon the local economy. It is easy to upset the balance of nature by removing apparently valueless shrubs —which, in fact, by providing some shade in arid areas, encourage the gradual establishment of more vegetation—or by removing animal wastes which would improve the land if left to act as manures.

In addition to these assessments of resources, studies of the way of life of the inhabitants, or of the way of life which could be envisaged following the provision of an adequate amount of energy, are very necessary. For, as already mentioned, the characteristics and magnitudes of the intermittent energy sources to be developed must be related to the demands—and particularly to the 'loading schedules'—which are likely to apply at the place concerned. For example, it would be a waste of effort and of money to provide electric light for a district in which the inhabitants normally rise with the sun and go to bed at sunset, thus having little need for artificial lighting of any kind. A supply of heat during the night time would, on the other hand, be useful in desert areas where the temperature falls greatly at night and where there is a severe shortage of local fuel. No doubt instances of this kind are common in underdeveloped areas, where little information is generally available to throw light on the question of energy utilization. But, even though sufficient were known of the existing way of life in such areas, special surveys with these considerations in mind would still be needed to form an accurate estimate of the possibilities of development.

INTERNATIONAL CO-OPERATION IN DEVELOPMENT

Although climatic and sociological conditions differ widely in the many areas which are classified as underdeveloped, there are clearly common problems to be faced by those responsible for their betterment. Attention has been drawn to the need for surveys and local studies which can only be undertaken by, or at least with the full co-operation of, the governments concerned. It would be out of place here to suggest what steps should be taken to encourage development, but it may be worth considering how far international collaboration can be of assistance.

The established organizations, such as the specialized agencies of the United Nations, are of course entirely competent to advise on the particular aspects of development or of improvement of conditions with which they are each concerned, and there are frequent conferences at which representatives of these organizations meet to discuss questions of mutual interest. But one wonders whether joint discussions of this kind are sufficient in themselves to bring about the intensive investigation which is needed to produce results on the lines suggested here. This is not to disparage in any way the excellent work which is being done, for example, by the Advisory Committee on Arid Zone Research of Unesco and by other committees concerned with more specialized subjects. Interest in the possibilities of using local energy resources is not however confined to arid zones. There seems to be a need for co-ordination of the widespread efforts already being made to gain information which may lead to practical applications. At present, research with essentially a common aim is proceeding independently in different places or, at best, with only loose contacts established between individual workers. There is in this field of endeavour little reason to preserve secrecy either about the methods to be followed or the results obtained in investigations. On the contrary, much effort can be saved by the interchange of information, but this interchange should have a more continuous basis than that provided by conferences of professional associations which take place at too long intervals.

It cannot be denied that many authorities responsible for development are not fully aware of what might be done through experimental work directed along the right lines. Another difficulty arises in meeting the cost. There are, indeed, many unknown factors in a project of this kind, and it would be unrealistic to suppose that it could be carried through to success without considerable effort. But there is not much doubt that the problems arising can be solved, and that the results would be well worth while. Is it quite out of the question for a pilot experiment or, preferably, two or three experiments in different parts of the world to be undertaken on an international basis, and for the results to be made known to all who might thereby benefit?

THE RIGHT TO SCIENTIFIC PROPERTY

This report was published on 10 June 1953 as Unesco document No. WS/053.62 under the title Introductory Report on Scientists' Rights. *It was prepared by the Unesco Secretariat for the use of a Committee of Experts on Scientists' Rights convened by Unesco. This committee met at Unesco House in Paris from 7 to 10 December 1953 under the chairmanship of Senator Marcel Plaisant (France), who was rapporteur on the same problem before the International Committee on Intellectual Co-operation of the League of Nations and its members included Dr. C. E. Sunderlin (U.S.A.), Professors A. Giacomini (Italy), H. C. J. Duijker (Holland), A. Lichnerowicz (France), T. Lund (Denmark), and M. A. Merlin (France). It adopted the following resolutions:*

I The committee is of the opinion that, apart from rights which are already protected in various countries by the laws relating to copyright, patents of invention, by common law and by various other laws, scientists might have other rights by virtue of their activity in scientific research.

II The committee has taken note of the increased awareness of this question in several countries. Studies of the problems involved are being pursued both at national and international levels.

III The committee accordingly recommends the study of the question by the Member States of Unesco in order to ascertain whether it would be practicable and advisable to make any changes in the present practices in these countries. The committee furthermore recommends that the Director-General of Unesco promote exchanges of information between Member States on the subject of existing practices in this field. The committee further suggests that the Director-General of Unesco promote the co-ordination of these studies.

IV During the meetings of the committee it was felt desirable to obtain information

1. on the status of scientists;

2. on the attitude of scientists themselves towards their rights.

The committee therefore suggests that the Director-General of Unesco promote and co-ordinate appropriate enquiries.

SCIENTISTS' RIGHTS

BACKGROUND OF THE PROBLEM

The question of the international protection of scientists' rights, which has sometimes been termed the protection of 'scientific property', was raised

over seventy years ago. It is worthy of note that the question was then brought up, at the same time as the problems of authors' rights, at a congress held by the International Literary and Artistic Association in 1879.

In practice, however, the problem has never been solved, probably because attention was concentrated throughout the studies on the financial implications of the proposal, which seemed to the governments consulted to be unacceptable or, at least, insufficiently justified.

Nevertheless, the question has always remained open and Unesco, in its general efforts to put the Universal Declaration of Human Rights into practice, could not fail to make a thorough study of it.

Article 27, paragraph 2, of the Declaration states that '. . . everyone has the right to the protection of the moral and material interests resulting from any scientific . . . production of which he is the author'.

It was natural that Unesco, after working out the Universal Copyright Convention, which is designed to protect scientific works in literary form —i.e. writings describing scientific doctrines or discoveries—should turn its attention to the protection of the content of such works—i.e. the discovery as such—from fraudulent appropriation.

DEFINITION OF SCIENTISTS' RIGHTS

Here it is necessary to draw a preliminary distinction which will, from the outset, prevent any confusion or misunderstanding.

A discovery may be publicized, become a cultural and social asset, and be put to economic use, in three different forms, corresponding incidentally to three stages of development which are logically and chronologically successive:

1. The discovery is made by a scientist who finds hitherto unknown or unrecognized connexions between certain phenomena or certain concepts, or simply discovers unknown or unrecognized consequences of scientific data which are already clearly established.
2. The author of the discovery gives an account of it in writing in a monograph published by a scientific journal or in a publication which is put on sale, or again, perhaps, in a verbal communication embodied in the minutes of a meeting of a learned body.
3. The technical application of the discovery makes possible its development for industrial purposes, thus opening the way to its practical utilization and economic distribution. The originator of this development (assuming it to be patentable) applies for a patent.

It is not proposed in this study to deal with the second of the stages defined above, where the rights of the scientist who has made the discovery are protected only as authors' rights with reference solely to the terms of the laws and international conventions concerning literary, artistic and scientific property, commonly known as 'copyright'.

Nor is it proposed to refer to the third stage, which comes under the laws and conventions concerning industrial property.

The only object is to consider what protection it may be possible to provide for the rights to which the author of the discovery can lay claim as regards the discovery itself, leaving aside the question of his possible rights in respect of copyright or industrial property.

For this reason, we shall deliberately refrain from using the term 'scientific property', which might give rise to confusion, and instead shall speak of scientists' rights, denoting a new category of rights, clearly differentiated from the other two.

HISTORICAL SURVEY

From 1879 to 1900

To give an accurate idea of the point now reached in the study of the problem of scientists' rights, it seems essential to sketch in briefly the history of the work done on this subject in various sectors and by different organizations.

Though the idea of embarking on a study of scientists' rights was first mooted in 1879 at a congress of the International Literary and Artistic Association, held in London, and rejected by that congress, the Association was later repeatedly urged to take up consideration of this difficult question. At Venice in 1882, at Berne in 1896, and at Turin in 1898, various members of the Association reiterated the original proposal of 1879. The only success achieved, however, was the adoption, by the Turin Congress, of a recommendation expressing a desire that all works of the intellect should be equally protected—or, in short, as it would be expressed today, that a body of general regulations concerning intellectual property be established. As a sequel to the adoption of this recommendation, some progress was made by the International Literary and Artistic Association, especially at a congress held at Heidelberg in 1899 and at another congress in Weimar in 1903, at which three reports were presented on the various aspects of what was then still called 'scientific property'. No further progress was made on the problem by that Association and, for all practical purposes, its consideration was adjourned *sine die* in 1928. It is to be noted, however, that, when Unesco's work was announced, discussion of this problem was once more put on the Association's agenda for 1953.

From 1900 to 1922

Although the consideration of scientists' rights hade made little progress between 1879 and 1900, it had attracted the attention of the public and, more particularly, of the people most intimately concerned. A congress of inventors' associations held in Paris in 1900, for instance, adopted a favourable resolution. In 1921, a congress, at which two learned societies and a union of scientists and inventors were represented, adopted a still more specific recommendation and, the same year, a congress of the Confédération des Travailleurs Intellectuels adopted a recommendation concerning the 'assimilation of patents for basic principles to patents for material things'. At the instance of one of the members of this congress, a first French bill on the subject was drafted ans published by Mr. Daliminer and Mr. Gallié. At about the same time, the Union des Syndicats d'Ingénieurs Français began to concentrate on the study of the question and requested Mr. Barthélémy, a member of Parliament, to draw up another bill, which was also introduced into the French Parliament.

Although these measures did not attract much attention at the international level, they did at least secure that of the League of Nations International Committee on Intellectual Co-operation, which in 1922 included in its programme the study of what was then still termed 'scientific property'.

From 1922 to 1939

This opened the international stage in the consideration of the question, which thenceforward proceeded at the level of the member governments of the League of Nations rather than at that of the non-governmental organizations or national legislative bodies.

For a time, the main centre of interest was the remarkably well-organized and very thorough work of the League of Nations and the International Institute of Intellectual Co-operation.

From the outset, all this work was centred on the need to secure for scientists, who were placed at a disadvantage by contemporary economic circumstances and the habits and social behaviour of the time, the means of maintaining a reasonable standard of living which would safeguard their intellectual independence in their research work.

It is important to note this tendency in the initial stages of international work, just as it was important to note that the original scheme for the protection of scientists' rights was developed within an association for the protection of copyright. The inference to be drawn from these two observations will be shown below. The only concern which is shown by the reports, questionnaires and discussions of committees of experts resulting from the work of the International Committee on Intellectual Co-operation is that of obtaining from industry pecuniary remuneration for scientists in recognition of the contribution they make by their intellectual activity to the practical applications of science exploited by industry in the economic field. The work in question was spread over a period of about 17 years, from 1922 to the second world war. A brief summary will suffice to show what was done.

As early as 1923, a distinguished Italian jurist, Senator Ruffini, submitted an important report which, without overlooking a single detail, gave a complete and succinct account of the whole problem and a faithful picture of the position at that time and of the opinions and trends of thought which had so far come to light. This report is still today one of the most important works of reference to be consulted on this question. It concludes with a draft international convention intended to serve as a practical basis for consulting governments, in the form of a request for views on the problem itself and on the solutions and inferences suggested by the report.

At about the same time, Professor Gariel, Deputy Director of the Bureau of the International Union for the Protection of Literary and Artistic Works (Berne Bureau) produced a scheme on an entirely different basis. In view of the difficulty of securing payment of pecuniary remuneration due to a particular scientist, as an individual, from the manufacturers making use of his invention, Professor Gariel recommended that a national fund be built up in each country, out of the proceeds of a small tax payable by all manufacturers, from which the authors of discoveries could be remunerated for their work. He also envisaged the possibility of setting up at a later date an international fund from which international awards could be made.

Only a few replies were received from governments on Senator Ruffini's

proposals and they were somewhat conflicting. They were set out in a first 'supplementary report' dated 12 August 1924. A plenary meeting of the International Committee on Intellectual Co-operation considered convening a committee of experts in 1925 and decided to consult manufacturers on the practical implications of the scheme. After these consultations, minor amendments were made to the Ruffini draft to take account of the objections advanced by governments and industrialists and, in December 1927, it was submitted to a committee of experts meeting in Paris. In the meantime, the International Chamber of Commerce had taken up the question in 1924 and the International Association for the Protection of Industrial Property had put the problem down on the agenda of its congresses in 1927 and 1928.

The results of the work undertaken concurrently by the International Commission for the Protection of Industrial Property of the International Chamber of Commerce, and the International Association for the Protection of Industrial Property, had been summed up in 1926 in the following terms, in the conclusion of a report prepared by Mr. Taillefer, a French legal expert belonging to both these organizations:

'The variety of answers submitted by the National Committees to the questionnaire sent out to them indicates alike the difficulty of the question and the doubt in which people are about the best ways of solving it. As the questions at issue—in the almost unanimous opinion of the people consulted—are in essence international questions, only to be solved by an international conference, i.e. by a unanimous vote by delegates of different countries, we are probably still far from a solution. This does not mean that study of the question should be dropped; rather the reverse, for the idea of scientific property represents an idea of justice, and any idea of justice sonner or later carries the day.'

The report on the work of the Committee of Experts of the Institute of Intellectual Co-operation was sent out to governments in 1930. In 1931, the International Committee on Intellectual Co-operation did no more than consider convening a committee of specialists. In 1933, it suggested resuming study of the question, which had been rather neglected, in the light of the large quantity of material collected over the ten past years.

At the end of 1937, the International Institute of Intellectual Co-operation, in a report by its director, noted that circumstances had not permitted the convening of the proposed diplomatic conference to discuss the draft international convention.

Finally, two congresses, held respectively by the International Federation of Associations of Inventors and Industrial Artists (Paris, 1937) and by the Confederation of Intellectual Workers (Helsinki, 1938), organized representations in favour of the recognition and enforcement of scientists' rights; but these led to nothing.

From 1939 to 1953

For practical purposes, therefore, on the eve of the second world war all the efforts made appeared to have failed in the face of public indifference, the opposition of certain countries and the less outright opposition of industrial circles. Hostilities naturally interrupted all this work and it was never resumed at the international level of governmental organizations or the major economic organizations until Unesco began to take action in

1952-53. Private organizations, however, had not entirely dropped the study of the question, nor lost all hope of finding the solution desired. Indeed, the Belgian Association for the Protection and Development of Copyright put the question down on its agenda in 1949, and the International Literary and Artistic Association decided to put this problem back on its agenda in 1953.

When we consider the history of all these successive efforts, we are driven to the conclusion: (a) that they had ended, if not in failure, at least in a deadlock; and (b) that, despite that failure, the need to answer sooner or later the question facing public opinion and governments remained as great as ever and that the final abandonment of all hope of finding a solution could scarcely be accepted. It is therefore well worth while to investigate the reasons for this failure.

RESULTS OF PREVIOUS WORK

Are we to consider that the problem of scientists' rights is an impossible problem, which can never be solved?

It does not seem so. The solution is admittedly difficult and so far no satisfactory answer has been found. But all the competent authorities concerned appear unanimously to desire it. It therefore seems legitimate to investigate new lines of approach and to try to find a method at once more exact and more practical than that so far adopted. The conclusions of Mr. Taillefer's report which are quoted above, and a passage in the report submitted in 1923 by Senator Ruffini, show that we cannot abandon our efforts to find a practical solution in so important a matter.

Senator Ruffini's comments were eloquent and precise:

'This omission [in the present legal system] will undoubtedly be a source of astonishment to future generations, just as we experience surprise at the defects in the legal systems of earlier times—defects which would be impossible at a later stage of civilization. A link is wanting in the chain of law which should secure due recognition to all the creations of the mind, from the most positive, the most concrete, the most practical to the most abstract, the most transcendental and the most ideal.' (League of Nations document A.38.1923.XII.)

Before considering a new method, it is obviously wise to investigate the weaknesses, not to say the errors, of that applied in the past, and to discover on what the criticisms of competent persons were based. From this point of view, the first comment to be quoted is contained in a report submitted to the International Committee on Intellectual Co-operation on 3 August 1928 by Senator Marcel Plaisant; it is worth quoting in full:

'In substance, the criticism expressed or implied most clearly in industrial circles is that scientific property is merely an abstract conception—*a right proclaimed by its advocates but one that is without definite object matter and attributes and that cannot be given actual application.* In short, this view expresses *fear of the unknown.* Rightly interpreted, the reservations made by the authorities consulted in England . . . and Belgium resemble the caution of a lawyer awaiting the further conclusions of his opponent before summing up the vital points of the discussion. Scientific property is passing through a crisis *de verborum significacione.*' (Marcel Plaisant, Report A.21, 1928.XII, dated 31.8.28, p. 2.)

The conclusion reached by the French branch of the International Chamber of Commerce was similar; it observed that everyone or practically everyone was more or less in agreement on the equity of the fundamental principle but that people were afraid of the difficulties and implications of applying it in practice. Why? Because the logical, legal concept was not clear and therefore its practical repercussions could not be foreseen. And also because it was consequently difficult to find any means of enforcing so ill-defined a right without dangerous practical implications.

These latter conclusions not only constitute a criticism of the methods used but contain an implicit suggestion which appears to be both wise and useful. It is quite clear that scientists' rights cannot be proclaimed, or their implications assessed, until their legal basis has been clearly determined. This seems to be simple common sense. For how can we decide how a right is to be enforced when we do not know in what that right consists or what is its logical justification and its legal basis? How indeed can we visualize even the recognition of that right?

ANALYSIS OF SCIENTISTS' RIGHTS

It therefore seems that the first step in a scientific approach to this problem is to define in logical and legal terms the right that common sense tells us exists and that the sense of equity tells us must be enforced within the social community, but whose essence and attributes are not exactly known to us. Let it not be thought, on falsely pragmatic grounds, that such an approach to the problem is purely academic and therefore of no practical use. It is in fact the only practical approach, for it is impossible to examine a problem and see what are its practical implications without first defining clearly the object with which it is concerned. It would seem necessary, however, to see first what is the present position and to note the opportunities legislation and jurisprudence at present offer the scientist for the safeguarding of any rights, as defined above, to which he might lay claim in respect of his discovery as such.

These rights may be analysed under two main headings:

1. A general and absolute right, applicable *erga omnes,* or in other words with respect to society as a whole, to be acknowledged as the author of the discovery. It is a purely immaterial, moral right; a right attaching to the person of the author of the discovery and hence, as lawyers would say, not '*in commercio*'—i.e. not capable of being ceded or transferred, particularly 'for a valuable consideration', and therefore not capable of being the object of contractual transfer.
2. A particular and relative right, applicable only in given conditions, in accordance with definite norms, and in respect of specified persons. This right, which relates to material interests, may be ceded for a valuable consideration and from it, therefore, the scientist may derive not only moral advantages but possibly also contractual or quasi-contractual patrimonial advantages.

How are these rights recognized, protected and enforced in the various legal systems as they stand at present?

PRESENT FACILITIES FOR PROTECTION

There are three cases to be considered, exactly corresponding to the three stages in the development of a discovery defined above:

1. The discovery has remained purely academic and its author has developed no form of practical application.
2. The author of the discovery has considered ways of applying it in practice but has not worked out the technical and practical details.
3. The author of the discovery has worked out the technical details of practical application.

The present legal position with regard to these three cases seems to be as follows in all countries, but more especially in those which have acceded to the Berne Convention on copyright and the Paris Convention on industrial property.

In the first two cases, the author of the discovery can reserve to himself no more than the moral right to claim priority of discovery. This is an extremely important point in the perpetual process of evolution and renewal which marks the progress of science just as it does the evolution of the arts. The question of date, the recognition of priority in time, is the fundamental element of the appropriation of an idea, a pattern or a technique.

Recognition of this priority can be secured more or less certainly by various processes, which constitute, in legal parlance, very strong presumptions but which—in the absence of an actual international organization—cannot constitute absolute and irrefutable proof.

These processes include: deposit of a sealed envelope containing the description of the discovery either with a notary public or with a learned body which is officially recognized and which has an officially organized procedure for such deposit; or use of the 'Soleau envelope' procedure organized at the International Bureaux for the Protection of Literary and Artistic Works and Industrial Property, whose headquarters are at Berne.

The first of these procedures may be recognized only nationally. The second is to some extent recognized internationally, but not universally.

In the event of a dispute, the opening of the sealed envelope may make it possible to fix a certain date in favour of the person who deposited it, which may secure him the benefit of priority to which he lays claim.

Lastly, the scientist may seek to secure moral property in his discovery by publishing a description of it in a special publication or in a scientific journal whose date of publication will help to establish the date, and therefore the priority, of the discovery. The only legal protection which can be invoked in this matter, however, is that resulting from the laws and conventions concerning literary, artistic and scientific property. Hence it follows that this protection covers only the literary form in which the discovery has been set forth and not the discovery itself. This means that the same discovery may be skilfully plagiarized by someone else, in a book or an article, without the original author being able to secure recognition of his claim to priority and therefore to moral property in the discovery.

In the national sphere, however, it should be mentioned that some countries have made provision, by legislation or regulation, for the protection of discoveries as such. Article 47 of the Spanish royal decree No. 1789 of 26 July 1929, amending the laws concerning industrial property, provides for the protection, by patent, of scientific discoveries. Article 3 of the

U.S.S.R.'s regulation dated 5 March 1942 affords protection to certain discoveries such as those relating to the treatment of diseases. Mention may also be made, although the field in question is somewhat specialized, of the protection of agricultural or horticultural discoveries, for which provision was made, in France, by the decree of 5 December 1922 and, in the United States of America, by the Plant Patent Act of 23 May 1930. Attention must also be drawn to current efforts for the internationalization of protection in the agricultural sphere, particularly those being made by the International Association for the Protection of Industrial Property and by the International Chamber of Commerce. The problems and cases involved in this instance, however, are generally on the borderline between the intellectual labour of discovery, which is the subject of this study, and the technique of invention, which we are leaving aside, at least for the time being.

In the third case, the author of the discovery which has been technically adapted for practical purposes and is therefore capable of industrial exploitation, can apply for a patent which, while securing him a temporary monopoly of industrial use, also gives him indirectly a right of authorship in his scientific discovery, but only, of course, if it is an original discovery and if its priority is not challenged by someone else on valid grounds.

Nevertheless, the formalities on which the grant of a patent depends, particularly in the many countries in which the grant is subject to a preliminary technical examination, make the issue of a patent problematical and compel the author of the discovery to undertake negotiations, discussions and expenditure—in short, plunge him into difficulties.

A memorandum recently submitted by the Netherlands National Committee to the appropriate commission of the International Chamber of Commerce[1] gives a very accurate account of these difficulties and of the risk involved, in the light of experience.

It is clearly apparent from the foregoing that the appropriation of a discovery to the person of its author at present has no certain legal basis and therefore no certain legal means of enforcement at the international level, and that the conclusion in the Ruffini report that 'a link is wanting in the chain of law which should secure due recognition to all the creations of the mind' is entirely justified.

LEGAL DEFINITION OF SCIENTISTS' RIGHTS

The most important thing is to define the legal nature of scientists' rights.

Legal technique requires, as the primary condition for the definition of a right, that the object matter be precisely stated and that the subject be exactly known.

So far as the subject of scientists' rights is concerned—i.e. the author of the discovery—it will be necessary to determine what persons come under the heading of 'scientist'. This is a more difficult question than might be thought at first sight. For convenience of discussion, we must begin, as mathematicians often do, by considering that this extremely important problem, which will be examined below, is already solved.

So far as the object of the right is concerned, which is obviously the

1. Document 450/39, dated 3 September 1952.

'discovery' made by the scientists, it is essential: to define the discovery; to specify the logical relationship with the person of the scientist who is its author; and to investigate the legal category of rights mentioned in the law which may be regarded as covering such a relationship.

1. A scientific discovery may be defined *grosso modo* as the observation, in the sphere of the natural sciences, of material relationships, not hitherto observed, between two orders of phenomena whose links with one another were previously unperceived. In the sphere of the exact sciences or the moral sciences, it is the observation of intellectual or moral relationships between two orders of concepts which had seemed to be unrelated.

   This very general definition which, both in the absolute and in its application to specific cases, no doubt requires more exact statement, is nevertheless, for the time being, an adequate basis for the consideration of the logical relationships between the discovery and its author.

2. These are, as will be seen, purely intellectual and moral relationships deriving directly from the personality and resulting from various operations of the mind.

   In the first place, as the basis for everything else, they result from prior study.

   Secondly, from the rational development of this study, which leads the scientist to full analytical perception of the various phenomena or concepts previously regarded as totally unrelated or at least as having no clearly defined and fully demonstrated relationship with one another.

   Lastly, from a sort of intellectual inspiration by which the previously unknown relationships are revealed to the scholar. This inspiration results from his own intellectual gifts and from the constant and often fervent application of his mind to the investigation of the relationships, at which he may already guess as a matter of hypothesis, but which he has never previously been able to determine and verify beyond doubt.

3. The logical connexions so defined come directly and indisputably under the legal heading of intellectual rights—the most familiar type of which, and that most specifically sanctioned by the laws, is copyright—rights over immaterial possessions, *Immaterialgüterrechte,* as they have been defined by the German jurist, Kohler. And it was probably not by pure chance that the idea of protecting scientists' rights was first raised internationally at a congress of the International Literary and Artistic Association, which was then preparing the ground for the future Berne Convention for the international protection of literary and artistic works.

   Such connexions, however, also introduce the theory of the rights of personality—the body, the 'universality' of rights which, in the terms of legal theory, are 'attached to the person'.

   Judging by the latest development of doctrine on the subject, copyright is to be considered as one of the rights falling within this last group. If we accept this theory, which seems to be accurate and well founded, the two categories of rights we have just mentioned (rights over immaterial possessions and rights of personality), which are often contrasted, would be merged in a single category, to which scientists' rights would naturally pertain.

   If this is their legal nature, scientists' rights fall into the category of general and absolute rights, applicable *erga omnes,* to which we referred above and which are 'non-commercial'. They are indissolubly 'attached

to the person' of the author of the discovery and, considered in themselves, cannot be the object of any form of dealing or contractual transfer; they are not matters of economics.

On the basis of this legal definition, it is important to determine the nature and attributes of these rights on the analogy—to which, however, we must have recourse with the utmost caution—of the solutions adopted in the fairly closely related field of authors' rights. So far as the nature of these latter rights is concerned, it is common knowledge that learned doctrinal discussions have taken place and are, moreover, still going on. The question has often been put whether these rights are rights of property in 'incorporeal possessions', a temporary privilege, or a personal right to profit.

Those who have voiced these various opinions have, in fact, adopted different points of view and have considered different aspects either of authors' rights in themselves or of the patrimonial rights deriving therefrom —in other words, in some cases from the standpoint of theory and in others from the standpoint of contractual practice. The result has been a certain amount of confusion with regard to principles, concepts and ideas, which we must seek to avoid in the study of 'scientists' rights'.

We must, it seems, in our efforts to answer the question before us, content ourselves here with considering the solutions chosen by those who have studied authors' rights as such, leaving out of account their patrimonial and pecuniary implications.

If we limit ourselves in this way, we are led to the conclusion that the scientist, by virtue of his rights of personality, automatically acquires over his discovery not a property right in the normal sense in which the term is used with regard to rights acquired over material objects, but a right of exclusive appropriation over an intellectual element, which he can sustain against all other persons.

What is the practical implication of this right? At this stage it is simply the absolute and exclusive right to attach his name to the discovery of which he is the true and, possibly, the sole author.

ATTRIBUTES OF THESE RIGHTS

Reference to previous works suggests the need for considering whether these rights may have attributes and derivatives in practice which would come under the heading of patrimonial rights or, in ordinary parlance, pecuniary rights.

This is an extremely important, in fact a vital, question since it was almost solely from this point of view that the work of the League of Nations, the International Institute of Intellectual Co-operation and the International Chamber of Commerce was initiated—and since it seems that it was for that very reason that the work of these three bodies finally ended, in 1932, in total failure, disguised by the polite formula of adjournment *sine die*.

In point of fact, no effort was made to go into the legal basis of scientists' rights—a fact remarked with regret by the French branch of the International Chamber of Commerce—and the sole object of all this work was to find some method by which scientists might have a share in the profits of the economic exploitation of their discoveries. It is clearly necessary, at this point, to ask ourselves whether a discovery is capable of immediate economic

development. As has already been observed, a discovery consists in the determination of the necessary relationships between two orders of phenomena or concepts and, as such, cannot be the immediate, direct object of economic exploitation. Between the industrialist whose activities may possibly derive logically but indirectly from the original discovery, and the scientist who originates that discovery, comes a necessary process of technical adaptation in which the personal labours of the scientist are very seldom involved. This is not discovery but invention. The discovery and its economic exploitation are therefore indirectly connected and in most cases a third person comes between the industrialist and the scientist—the technical inventor.

It is with the latter, in whose name a patent has generally been granted, that the industrialist has direct contacts which may give rise to mutual legal obligations embodied in the exclusive rights conferred on the inventor by his patent and those accruing to the industrialist from the contracts concluded with him for the use of this patent.

In such contractual and partly commercial negotiations, the scientist who has not himself worked out the details of the technical and practical application of his discovery is no more than a 'third party'—in the legal sense—with whom the industrialist has no legal ties and in respect of whom he has contracted no legal obligation.

Now that we have considered, not strictly speaking the three persons but the three social functions involved in the complex of activities in connexion with which the problem of scientists' rights has arisen, it seems necessary to define exactly the 'subject' of the rights in question, i.e. the scientist.

DEFINITION OF THE 'SCIENTIST'

Who is this 'scientist' whose rights we are seeking to protect? It would seem that there are scarcely more than three hypotheses to be considered. The following would be regarded as scientists: (a) anyone holding university degrees in science who is recognized to be the author of a discovery which has been duly noted and verified; (b) anyone who is recognized as a scientific research worker although he has no university degree, and who is also recognized to be the author of a discovery which has been duly noted and verified; (c) anyone who, though not holding a university degree in science or recognized as a scientific research worker, is nevertheless in fact the author of a discovery which has been duly noted and verified.

This last hypothesis obviously appears at first sight to be the most practical and the most reasonable.

The final decision between these three hypotheses—acceptance of two of them or of the three together, but in a fixed order and subject to appropriate provisions for discrimination—is a matter for the committee of experts and the governments to which its recommendations are to be submitted.

It is quite clear that this is a key problem on which the various recommendations of this committee are bound to depend.

It is permissible, however, leaving aside the solution of this problem, to put forward practical suggestions regarding the actual recognition and protection of the two categories of rights to which the author of a discovery can lay claim.

This will be the subject of the second part of this report which, in this respect, will be largely based on the results of previous work.

PRACTICAL MEASURES FOR PROTECTION

It should be noted from the outset that this section of the report is conjectural and intended purely for information.

It is indeed the experts who must take decisions on the problems with which it deals, and which experience has shown to be particularly difficult to solve. We shall therefore merely give a brief critical description of the solutions contemplated in the course of previous work without, however, ruling out the possibility of putting forward any suggestions which may seem helpful.

The authors of discoveries may lay claim to two basic categories of rights, or more accurately to one general right presenting two major facets, according to whether it is considered—to follow the terms of Article 27 of the Universal Declaration of Human Rights—from the point of view of their moral interests or of their material interests.

The distinction between these two orders of interests necessitates separate study of the problems arising out of the two different aspects of this right, for the legal norms for the recognition and enforcement of 'non-commercial' rights attaching to the person differ considerably from those governing the recognition and enforcement of contractual or quasi-contractual rights to profit. This applies both to their application and to their practical implications.

This brings us to consider one by one the practical measures for protection suggested in the course of previous work with regard to: the rights attaching to the person of the author of the discovery; the rights to profit which may accrue to the author of a discovery from its economic exploitation.

RIGHTS ATTACHING TO THE PERSON OF THE AUTHOR OF THE DISCOVERY

INTELLECTUAL RIGHTS

It must be mentioned at this point that the study of the first branch of the problem (definition and legal nature of the intellectual right attaching to the person of the author of a discovery) has so far been neglected—most regrettably, as many leading jurists have remarked in the opinions quoted above that they have given on this subject.

As for the study of the second branch (patrimonial attributes of scientists' rights), it has led to nothing because of the practical difficulties of applying the theoretical solutions considered and because of the opposition legitimately displayed by the industrial world owing to the lack of precision about the rights which it was proposed to sustain against industry.

But there are also other psychological reasons for this failure, which have

been less clearly brought out because they were less obviously apparent. While certain associations of scientists, including (it must be emphasized) inventors, have advanced precise claims on this point, the attitude of the 'pure' scientist engaged in research for its own sake—which is the only thing with which we are concerned here—has been extremely reserved, not to say hostile. The latter, indeed, are working neither for immediate—or even indirect—practical application, nor for personal gain. It may even be said that most of them, whatever the material difficulties of modern life, dislike so much the idea of turning their purely intellectual labours into money that there are grounds for fearing that they would dissociate themselves from a campaign whose principal object was simply to secure them a pecuniary profit which they do not seek and the thought of which alone might disturb and debase the very character of their research.

If we are to cover the whole problem as hitherto presented, however, we must not fail to consider in the course of this report both aspects of the right we are studying, especially as the previous works we have to take into account are mainly, if not exclusively, concerned with its patrimonial aspect.

It must be emphasized that the study to be undertaken, logically requires that we should begin by devoting ourselves exclusively to defining the legal nature of the right in its purely moral aspect before embarking on an investigation of the patrimonial rights which may derive from it. Indeed, if the legal basis for the right did not exist, how could we even contemplate deriving from it any consequences whatsoever?

In point of fact, the specific protection of these rights does not seem to have been the main consideration of the authors of the studies and reports submitted to the various congresses and expert committees which have discussed the problem from the outset. There is not even any sign of concern, in the many discussions which have taken place on this subject, for the protection of these immaterial rights as such. The most that can be said to emerge is a tacit and more or less conscious reference to certain ill-defined personal rights, in speaking of which Mr. Gallié, one of the members of the Committee of Experts which met in 1927, indeed used the term 'moral right', though he did not go on to draw the legal and practical consequences from this concept. The idea was taken up, a year later, by the Italian jurist, Stolfi, who dealt with it a greater length.

And, while we find in the studies, reports and discussions a constant, uniform desire to give scientists' rights recognition by allotting the scientist dues payable out of the industrial and commercial profits of economic exploitation more or less indirectly and more or less arbitrarily connected with his discovery, nowhere do we find the desire to give any precise legal recognition and credit to that discovery and to its author's rights over it.

Therein, very truly, lies the real reason for the absence of clear definition to which Senator Ruffini, Senator Plaisant and, above all, Mr. Taillefer drew attention, in different forms, in their reports.

It is thus quite natural and understandable that people have failed to consider the recognition, protection and enforcement of a right which, for lack of definition, has not been comprehended as clearly as could have been wished.

At most, the proposed system of national or international 'awards' to scientists for their work or their discoveries might have been regarded as likely to secure indirect recognition of the authorship of a discovery in the

person of its author. It is clear—to take an instance from an existing system which is universally recognized, but only *de facto*—that a scientist who has been awarded one of the Nobel Prizes can justly, until proof to the contrary is produced, claim to be the sole author of the work and of the discovery for which the prize was awarded.

But while the moral recognition of authorship may, in such a case, be regarded as secured with respect to society as a whole, in the absence of positive legislation on the subject, it can be neither protected nor enforced in practice. Moreover, the system of official national and international 'awards' to scientists, which had been advocated as early as 1923 by Professor Gariel, the Deputy Director of the Berne Bureau, was finally omitted from the draft of the proposed international convention by the meeting of experts in 1927. It is thus necessary to seek a positive and practical means of ensuring the recognition, protection and enforcement of the scientist's right of authorship in the discovery he has originated. This is certainly one of the fundamental points on which the experts called together by Unesco should work and submit recommendations.

It would certainly be inappropriate, in this context, to anticipate the result of this work or to lay down any general directions on the subject for the experts. But we surely do not encroach upon their independence and sovereignty of judgment if we suggest—as the experts of the ICIC, incidentally, had already suggested in 1927—that a higher authority, covering the whole world, should be organized by international agreement, with powers of examination, verification and decision. The work of this authority would be seconded in the various countries by official learned societies and duly recognized scientific bodies, and its regulations might be based, for example, on the practices of the Nobel Institute and its juries, which are sanctified by custom and by public international consent.

If a certain degree of world-wide publicity could be given to the work of such a body, claims might usefully be lodged in connexion with certain discoveries as yet unpublished, and the progress of world science might greatly benefit thereby, as it already benefits from the publication of patent specifications by the English-speaking countries.

What practical recognition—other than prizes, with which we are not concerned here—of their rights of authorship in their discoveries could scientists receive from such a body? The actual form is of no great importance, but is has been suggested in the course of previous studies that the frequently advocated system of 'patents for basic principles' be adopted and made general. Another possibility would be a system of certificates of discovery similar to the certificates of invention provided for in Soviet law.

Such patents or certificates held by the authors of discoveries might furnish not unimportant evidence for the prosecution of claims, not only for the authorship of the discovery itself but also for any material advantages accruing therefrom, which in this case would be based on a definite, internationally recognized title.

If, however, we are to cover the whole of this question which, from the practical point of view, is highly complex, we must not neglect to mention as this point a difficulty which—unimportant as it may seem in theory—is in practice considerably more weighty: the question of joint discoveries.

Though, for the convenience of argument, the hypothesis adopted has always been that of an individual discovery, in the present state of scientific

research, it is actually less and less common for discoveries to be made by one man working alone.

Apart from the fact that a discovery may relate only to one factor in a whole group in which the other factors are due to other research workers, owing to the very considerable resources required for modern research a discovery may be the work of a team of scientists or an organized laboratory, and may even, through such a laboratory staffed by paid research workers, be claimed by an industrial company. In this last case, there arises the problem of discoveries made by permanent salaried employees which, quite recently, has been the subject of complicated discussions at international legal congresses and which is still far from any universally accepted solution.

This point should also receive particular attention from the experts, who should seek, if not a solution applicable to all possible cases, at least a theoretical solution which could be applied, with suitable variations, to the infinite diversity of individual cases.

POSSIBLE PATRIMONIAL RIGHTS OF THE AUTHOR OF A DISCOVERY

POSSIBLE PATRIMONIAL RIGHTS

This brings us to the most difficult point. It is the point which has given rise to the most heated discussion and the most legitimate uneasiness, particularly on the part of the industrial world. Industrialists, in fact, have been afraid of the imposition of further financial burdens which might result from imperfectly defined rights and might, moreover, be more or less impossible to foresee until the claim of the author of the discovery was lodged.

This is not to say that industry refuses to accord pecuniary recognition to the intellectual and scientific contributions whereby it is enabled to produce and develop new products from which its wealth is derived. It has already accepted willingly and without complaint the financial burdens represented by the purchase of a patent or a licence to manufacture and the corresponding royalties. Nor did manufacturers in most countries decline, during the survey carried out by the Institute of Intellectual Co-operation, to accept the principle of payment to the author of a discovery in order to encourage the research to which the progress of science and of industry is due. But they agreed only on condition that the basis of the charge was clearly stated and that they could assess its amount, since otherwise it is clearly impossible for them to work out cost prices and consequently to fix selling prices in line with possibilities of the national and international 'market'.

It is therefore necessary to proceed with the utmost caution in these matters. But certain principles can be laid down, most of which follow, incidentally, from the observations set out in the first part of this report and from the general principles of common law.

With Respect to the Industrial Exploiter

1. In the first place, it should be borne in mind that, in relation to the industrialist making use of a discovery, the author of a discovery which

has not been technically adapted for industrial use is simply a 'third party'—i.e. a person with whom the industrialist has no legal ties and a person whose individual 'contribution' he cannot be said to be using.

2. As two Italian jurists, Senator Ruffini and Mr. Stolfi, have observed, the author of a discovery cannot, in any case, base a claim on the indirect use of this discovery. Only direct use can be taken into consideration, i.e. if, as only rarely happens, the industrial use represents the immediate and exclusive application of a discovery made, for instance, in the laboratory, or if the author of the discovery has himself developed the technical details of industrial use and has taken out a patent in his own name. This last hypothesis, however, brings us back to the case of the patented invention, the legal and contractual regulations governing which are clearly defined, contested by no one, and outside the terms of this report.
3. Under the standard rules governing commutative contracts, giving entitlement to a pecuniary or other consideration, it must be possible to show evidence of the actual furnishing of an equivalent consideration in order to earn entitlement to the consideration in question. Clear proof of the furnishing of this equivalent consideration must be adduced and the onus of proof is on the claimant—in the case in point, the author of the discovery—if he wishes to compel the industrialist to enter into a contract with him.
4. As regards the quasi-contractual rights recognized in all codes of law, relating—in the broad sense—to rights accruing from the use, otherwise than under contract, by a third party, of undoubted rights which he should have acquired by contract, or to rights to compensation for detriment suffered accruing to an injured party, it is clear that:
   (a) in the first case, there can be no question of such rights except on the assumption that undoubted rights exist which ought to have been acquired by contract; and
   (b) in the second case, no detriment can be alleged by anyone who is not the holder of undoubted and indisputable rights.

This brings us back to the application of the principles set forth under (1) and (2) above, and leads to the conclusion that the quasi-contractual rights of the scientist could be invoked against the industrial user only if the industrial use derives directly from the discovery and represents purely and simply the transference to the industrial sphere of a discovery made, for example, in the laboratory.

In this latter case again, however, the question arises whether, if the author of the discovery has not taken out a patent which it would have been open to him to claim, it may not be considered that he has decided, as many disinterested scientists have done, to leave the discovery in the public domain.

As will be seen, in this respect too, the problem is a complex one and the premises are confused. One of the main tasks of the experts would appear to be to clarify it by stating the premises more clearly.

The whole of the foregoing, however, is concerned only with the legal relations which may exist between the industrialists and the author of a discovery. We still have to consider those which may come into being between the author of the discovery and the person who, starting from the purely theoretical discovery which, as such, cannot be put to industrial use,

develops a technique which will make such use possible—the person known as the inventor.

With Respect to the Inventor

Generally speaking, the inventor is the only person known to the general public. Under the present laws on the protection of industrial property, he alone can apply for the patent, in his name, which will give him, for a limited time, an exclusive monopoly of the use of the invention, for, in most countries, only inventions capable of immediate industrial exploitation can be patented.

How are we to conceive the legal ties which may exist between him and the author of the discovery which furnished the starting point for the development of his technical invention and without knowledge of which he would most often never even have conceived the first idea which inspired his invention?

Here, though the legal relations between the inventor and the author of the discovery are not absolutely clear, the intellectual 'contribution' of the author of the discovery is plain, and an undeniable causal link can be shown. Although the author of the discovery cannot, strictly speaking, sustain in relation to the inventor a specific right to profit of contractual or even quasi-contractual origin, it would seem that he has grounds for invoking, with certain reservations and in certain conditions, the theory of unjust enrichment[1] (the *rem versum* of Roman law) against the inventor who has merely developed the practical details of application of his theoretical discovery.

During the discussion of the committee of experts convened in 1927 by the League of Nations International Committee on Intellectual Co-operation, this view, logical enough in itself, suggested a definite proposal put forward by Mr. Gérard, the Director-General of the Comité Central Industriel.[2]

This proposal was so hotly opposed by all the other experts that it was finally withdrawn by its author. Its opponents feared that it might involve a dangerous confusion between 'scientific property', as they called it, and 'industrial property' which governs the question of patents.

It may be wondered, however, whether, in view of the fairly sound logical basis for the proposal, it would not have been possible to discover an acceptable legal foundation for the rights of the scientist, the practical implications of which could easily have been determined. It may even be asked whether the acceptance, not of the confusion of two rights but of a certain parallelism between them, would not open the way to a well-balanced international organization calculated to facilitate the investigations of industrialists in order to cover themselves against the risks to which they might be exposed as a result of the creation of the new rights.

In point of fact, any industrialist contemplating the acquisition of a patent, or of a licence for the use of a patent, has thorough investigations made by his specialized services and by his adviser on patent rights regarding any 'priorities' likely to be brought up against him, the subsequent disclosure of which might interfere with his use of the patent and cause him what would often be considerable detriment. If, during these investigations, the claims

1. Very closely related—save for the quasi-contractual idea—to a quasi-contractual obligation.
2. Document ICIC. 196, Geneva, 4 June 1928, p. 16.

of the author of the discovery could be brought to light by some means, he would then be faced only with a single claim which he could satisfy by a single bargain or by two concomitant and interdependent bargains.

This last point also seems to deserve serious consideration by the experts.

CONCLUSION

In any case, the practical solution of all the problems referred to above must depend, primarily, upon the establishment of some legally recognized international title in support of the claim of a scientist to authorship of his discovery.

It must also depend on a condition which is essential in all matters but more particularly in legal matters—precise definition of terms, especially: the definition of a scientist; the definition of a discovery; the definition of an invention and of an inventor; the definition of the functions of the international and national authorities responsible for receiving and registering declarations of discoveries; the definition of their status, of the procedure for registration and of their issue of the 'title' in the discovery; the definition of the rights of the holder of such a title, in what they consist, their effects and their duration.

Even so, the very complicated problem of the protection of scientists' rights will not be immediately solved, for it will still be necessary to decide whether, and in what circumstances, it is wise to protect only the moral interests of scientists—a point which, in itself, raises difficult practical problems—or to proceed immediately to the no less difficult field of the recognition of their right to protection of their material interests and the enforcement of that right. This is a problem which may seem simple in theory but which, in practice and in specific cases, is infinitely complicated by the interplay of individual and general interests, scientific interests and economic interests, all so closely associated with one another.

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